THE FRONTIERS OF AGE:
ARTS AND THE EXTENSION OF FERTILITY TIME
IN SWITZERLAND AND BEYOND

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[2] Beatrice Bain Research Group, http://bbrg.berkeley.edu/ - accessed on January 4, 2016.
[3] The Center for Science, Technology, Medicine and Society, http://cstms.berkeley.edu/ - accessed on January 4, 2016.
[4] Institut Universitaire d'Histoire de la Médecine et de la Santé Publique, http://www.chuv.ch/iuhmsp - accessed on January 4, 2016.

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1. Introduction

During the summer of 2013, a friend sent me an email with a link to an article published in the *Tages Anzeiger* (Althaus 2013), a widely-read daily newspaper in the German-speaking part of Switzerland. She described it as a comforting article. Entitled "The Fertility Panic"[5], it begins with a close-up picture of a smiling woman holding a young baby in her arms. "Late happiness"[6] comments the subtitle, referring to the Australian woman, Anthea Nicolas, mother for the first time at age 50 without medical assistance. Following the picture, the author warns about the supposed truth of the fertility decline figures conveyed in the media and the distorted view of reproductive doctors on that topic. Fertility does decline, but not as quickly and drastically, as it is believed to after age 35. Through reading I discovered that this article was actually drawing on and repeating a highly-publicized article published in the American magazine *The Atlantic*. Entitled "How long can you wait to have a baby?" (Twenge 2013) it was circulated and discussed under titles such as "Everything you thought you knew about age and fertility was wrong" (Grose 2013), "Doctor challenges women and fertility myths" (Boudreau 2013) or in a more critical way "The Atlantic's fertility story just told so many women what they want to hear" (Johnson Wheeler 2013) and "The inconvenient truth of fertility decline" (Daly 2013).

The original piece was written by Jean Twenge, professor of psychology at San Diego State University and author of the book "The impatient woman's guide to getting pregnant" (Twenge 2012). Drawing on her own experience of the pressure entailed by the fear of waiting too long to be able to have children, as a mother of three children each conceived without medical assistance within a few months after age 35, and as a scholar trained in the reading of scientific articles, she presents the results of her research about the fertility decline. Adopting a whistle-blowing tone, she claims that the fertility decline of women in their thirties has been "oversold" and proposes to present what the "statistics really tell us". She points to the fact that the fertility decline figures, which have been spread uncritically in the media, in medical discourses, and are responsible for creating a "baby panic", are in fact based on questionable data, that is historical data from French births records from 1670 to 1830[7] (Twenge 2013). She also presents more reassuring statistics taken from recent studies (Dunson, Baird and Colombo 2004; Rothman et al. 2013), and concludes that couples should not let themselves get stressed by a scare-mongering rhetoric about the end of fertility pushing them to have a child before feeling ready.

[5] "Die Fruchtbarkeits-Panik" in German.
[6] "Spätes Gluck" in German.
[7] She does not mention the author of this study in her article, but she is probably referring to the work of Henri Leridon (see Chapter 3).

After reading this article I could understand why my friend called it "comforting". It was offering hope. Hope that knowledge about the fertility decline was biased and not so deterministic, hope that women should not be worried about their "biological clock", hope that they could have babies when they felt ready, without medical assistance. As Grose's and Johnson's comments of Twenge's article conclude, "It's good to hear that our bodies will cooperate with the way society has changed" (Grose 2013) and "There are no three words more seductive to modern women than 'You have time'" (Johnson Wheeler 2013). Somehow Twenge's piece was offering an empowering and liberating breath. On the other hand, I could not help but remain dubious about the revolutionary aspect of that message. After all, the author was just recommending to start "stressing" at age 40 rather than at age 35. I could also not help but think of the experiences of the women I had met, facing painfully the idea that their "time was over" and experiencing in their bodies the limits of their fertility under the form of treatment failures and miscarriages. I also thought of the medical practitioners whom I had interviewed who felt powerless to do anything about age and for whom the age-related decline of fertility was a component of their daily practice. Did they all have a distorted view of the fertility decline? Was the scientific knowledge about age-related infertility a big trickery?

In February 2014, like an echo to these questions, my Email box alimented by an RSS feed received news from the Centre for Genetics and Society's blog. Entitled "Women don't need any more big lies", the original article was published in CNN (Selvaratnam 2014b). The author presents in it the main ideas of her book "The Big Lie: Motherhood, Feminism, and the Reality of the Biological Clock" (Selvaratnam 2014a). Released in January 2014, the book received wide media coverage, above all in women's magazines such as *Elle*, *Vogue*, and *Cosmopolitan* and various blogs, under titles such as "Facing the fertility lie" (Winick 2013), "Postponing motherhood: when does it become actually too late?" (Selvaratnam 2014d), "Face it: you can't have a baby whenever you want" (Grigoriadis 2013). Drawing on her own experience of three miscarriages, removal of cancerous cysts after pre-IVF screening, divorce and childlessness, Selvaratnam wants to draw attention to the other side of the success stories of older motherhood. According to her presentation on her blog, her book is intended to be a "conversation-starter" and a "policy-changer"[8]. In interviews, she states that the biggest lie is that women believe that they are able to have children whenever they are ready and that if they encounter difficulties, science will rescue them. With indignation and resentment, she observes that "We have been a guinea-pig generation when it comes to delaying fertility" (Selvaratnam 2014c). She also criticizes the lack of public

[8] See her blog: http://tanyaturnsup.com/about/ - accessed on August 20, 2015.

awareness about the age-related fertility decline and advocates for better information, for example in the form of the presentation of fertility charts, routine ovarian reserve testing, and egg freezing before age 28, along with other social measures, such as making IVF accessible to more people through insurance coverage, or improving day-care facilities and other means to allow a better reconciliation between motherhood and career (Grigoriadis 2013; Richards 2014; Sachs 2014; Selvaratnam 2014c; Welch 2014).

The symmetry between these two messages struck me. Both authors, adopting a whistle-blowing tone, try to reestablish veracity about the relationship between age and fertility and to sort out the truth from the lies. Both are smart, well educated, professionally successful, live in America, and draw on their own experiences of in/fertility to narrate their stories and defend a more political message concerning other women. Both are criticizing the production and circulation of scientific and medical knowledge about the fertility decline and assume that something is wrong with medically assisted reproduction. This is the point where their visions diverge and their accounts become asymmetrical. When the first one criticizes the panic about infertility created by alarming statistics taken from old and biased data, the second one criticizes the lack of accurate knowledge about the fertility decline and the false illusions produced by the development of reproductive technologies. In both cases, the authority of reproductive medicine is put into question in an attempt to empower women, but in two very different ways. Whilst the message of the first one is to not be stressed by scaremongering false statistics and to have a child when one feels ready, the other one advocates for the better diffusion of knowledge about the age-related fertility decline, allowing women to make better-informed choices and to take their reproductive lives in their hand, and criticizes the very idea of "waiting to be ready". When the first one assumes that statistics are not reliable enough, the second one regrets that they are not taken seriously enough.

Beyond their opposition, these two messages are representative of public discourses surrounding age-related infertility and late motherhood, and of what I call the "question of age". I use this term to point to age as an entity whose status is precisely what is under question and as an assemblage of several social, biological, political and ethical questions. Connecting intimate decisions, statistics, bodily experiences, science, hopes, disappointments, sufferings, society, work, politics, futures, truth, lies, the questions of age circulates in the world of the Internet, women's magazines and newspapers under headings such as "parenthood", "health", or "women". Its exploration encourages the highlighting of the contested dimension of knowledge about the fertility decline, its material dimension in the form of miscarriages and childlessness,

but also fertility charts, figures, statistics, as well as its discursive dimension associated with truths, lies, and partial perspectives.

Drawing on the seminal works of Sarah Franklin, Charis Thompson, and Carrie Friese, this dissertation aims to explore the "question of age". It contributes so to the study of assisted reproductive technologies[9] (hereafter ARTs) by taking into account the underexplored dimension of age and aging. By following the relations between age/aging and ARTs in the science of infertility, the experiences of women undergoing ARTs treatment and the biopolitics of the medical extension of fertility in Switzerland, I will explore several facets of the "traffic" (Haraway 1991a; Squier 2004) between the reproductive and anti-aging[10] sociotechnical projects and show how multiple natures of age result from it. This dissertation is thus about some of these ramifications and the ways in which nature, society, bodies, temporalities, and promises work together to make reproductive aging both something that is based on uncertain facts, and that matters most when it comes to the experience of in/fertility in the context of reproductive medicine.

1.1. Making a way between essentialism and constructivism

How to understand the contested reality of reproductive aging from a social sciences perspective? How to account for the dual aspect of this category that is "biased" on the one hand, and whose reality is not taken seriously enough on the other? In other words, how to deal with the two conflicting views that the biological reality of the age-related fertility decline might be too influenced socially, and that it might matter much more than what is usually thought? Trying to answer these questions inscribes the discussion in the long-standing theoretical debates animating anthropology, gender studies, and STS, about the nature/culture divide, and especially in the recent ontological and materialist turn. Trying to go beyond a social constructivist stance, this turn is characterized by a move from epistemology and representationalism[11] to ontology and matter (e.g. Coole and Frost 2010; Harris and Robb 2012; Henare 2006; Mol 2002; Rahman and

[9] I use the term "assisted reproductive technologies" to designate the range of technologies contributing to assist couples medically in conceiving a child. This includes technologies such as sperm insemination, in vitro fertilization, ICSI, egg donation (see glossary, appendix 1). When I refer to a more specific technique, I mention it.

[10] The use and meaning of the term "anti-aging" are debated among gerontologists and "anti-aging" medicine, as well as among social scientists studying this field (see Latimer 2011; Mykytyn 2006, 2010; Vincent 2006). Following the analysis of anti-aging medicine in the US done by Mykytyn, I use the term to designate the scientific and medical practices assuming that aging can be targeted for biomedical intervention, and aiming at preventing age-related diseases and promoting optimal health (Mykytyn 2006). It includes "regeneration therapies" (Squier 2004) and the hopes associated with stem-cells, nanobiology, and gene therapy (Mykytyn 2006).

[11] "[…] representationalism is the belief in the ontological distinction between representation and that which they purport to represent; in particular, that which is represented is held to be independent of all practices of representing. That is, these are assumed to be two distinct and independent kinds of entities – representation and entities to be represented" (Barad 2003: 804).

Witz 2003; Tuin and Dolphijn 2010). The goal is to take the material reality into account, while avoiding the trap of essentialism– there is a reality out there that is not influenced socially – and of social constructivism – everything is social or discursive. In other words, it is an attempt to answer the question of how something can be both constructed and real at the same time (Hacking 2008). Instead of focusing on how we know things and how we interpret them, this line of thinking invites us to apprehend meaning and thing, or the social and the material, as one, as "inextricably fused" (Barad 2007: 3), or as "co-constutive forces" (Tuin and Dolphijn 2010: 161).

In order to situate my approach to these questions and show how this line of thinking might be useful to tackle the reality of reproductive aging, I would like to turn to two articles that I read at the very beginning of my research. They both examine the "question of age" in their own way and were important in the development of my reflections. These articles constitute crucial analyses in the research field on older parenthood, and my goal is not to criticize them in order to show that my work is better (on the complex use of literature, see Mol 2002). I rather agree with most of their argument. The goal is instead to account for my own sense of frustration while I was reading them and for the limits I could identify regarding my own fieldwork and how I tried to develop ways of going beyond them.

The first study entitled "The so-called late pregnancies in France: public health problem or social dissent?[12]" focuses on the social construction of so-called late pregnancies as a public health problem (Moguérou et al. 2011). The use of the term "so-called" (in French "dites") already creates a distance between the object and its construction, proper to representationalist approaches. Finely analysing demographic statistics, the authors show firstly that so-called late pregnancies are of minimal importance in regard to the whole number of pregnancies, and secondly that late pregnancies in the case of blended families and classic large families are more numerous than for primiparous[13] women. The authors also highlight the gender bias, present in the focus of the media and medical discourse only on older mothers even though late fatherhood is statistically more important. They establish a distinction between the time of biology – which is related to female physiology and fixing limits to procreation – and the time of norms – determining, prescribing, or stigmatizing reproductive trajectories (Moguérou et al. 2011: 14). In this account, medical discourse and scientific knowledge about late pregnancies are interpreted as a moralizing enterprise reassigning women to the dominant procreative norms of the good

[12] Original title: "Les maternité dites tardives en France: enjeu de santé publique ou dissidence sociale?". Translated by the author.
[13] Giving or having given birth for the first time. In the context of the article, the term is used to differentiate women who postpone childbirth and have their first child when older, from women who have additional children (not the first one) when older.

moment to have a child, which is more strictly defined than the physiological limits of fertility, which would be much looser.

In this account, one can observe the establishment of an analytical distinction between social, and especially gendered, norms, and the biology of reproduction. Here the idea that fertility is biologically limited is understood as part of a medical discourse participating in the politics of reproduction. The statement of a gynaecologist (Bellaisch-Allart 2005 cited in Moguérou et al. 2011) recalling that women cannot have children when they want, as the feminist slogan "a child when I want"[14] would let believe, is interpreted as normative, moralizing, and alarmist. However, the biology of age-related infertility is not discussed in itself. The age-related fertility decline is rather understood as social, political, discursive and in relation to the heteronormativity of society. In short, the age limits of motherhood are mainly, if not only, social. To show that so-called late pregnancies are constructed as a social problem enables the authors to highlight their gendered and political dimensions, which have more to do with women's place in society and the norms of "good motherhood", than with the biology of the fertility decline, which is not discussed. They are thus in line with the feminist concern "to displace prevailing naturalist, essentialist paradigms of gender and sexuality and secondly, to replace them with explanations of gender/sexuality which demonstrated the social and structural bases of gendered inequalities" (Rahman and Witz 2003: 247), that is, a "social ontology" of gender and sexuality (Rahman and Witz 2003: 247).

While I agree with their analysis and political agenda, I think that it has also some limits. Firstly, the role that ARTs play in the construction of this social problem is not discussed or taken into account. Even though these technologies might only concern a statistical minority of older mothers, they deal very directly with the biology of the fertility decline and thus constitute a relevant place from which to explore the making of relations between age and fertility. The minimization of the role of ARTs in the making of older parents and in the transformation of age norms can also be found in another very interesting study. In their book, *Parents after 40*[15], Bessin and Levilain (2012) criticize the importance ARTs take on in public discourses, and doubt that egg donation has any impact on this phenomenon (Bessin and Levilain 2012: 163). In their wish to criticize media and medical discourses which are sometimes saturated by the presence of ARTs, the authors avoid exploring the medical practices and specific experiences of people turning to these biotechnologies to have a child. But by doing so, they leave it somehow

[14] "Un enfant quand je veux". Translated by the author.
[15] Original title: "Parents après 40 ans". Translated by the author.

blackboxed, while I assume, on the contrary, that it is by researching the relations on age and fertility in this setting that we can complicate the role that ARTs play in the construction of late motherhood as a social problem.

Secondly, the distinction between nature and society – time of biology and time of norms – while enabling the development of a feminist critique, also leaves unproblematized the question of the nature of biology. The distinction itself is problematic, in the sense that it reproduces the idea of nature as a passive matter, to which culture would give meaning and order, as shown in the rich literature on ontology and materialism. But the idea that limits of maternity are only social or discursive, and tied up with the representation of motherhood as incompatible with aging, does also not allow me to account for the experiences and practices that I encountered in the field of reproductive medicine. In this setting, age limits are not just a normative idea, or a discourse. For the people I met, they have a direct impact on their life, and on their inability to have a child and to create a family. They were not just read about in a magazine, something irritating in the air, they were also embodied and very material in many ways.

Thirdly, what is at stake concerns also the position of a social science researcher regarding the medical science he or she is studying. In the account by Moguérou et al., media and medical discourses are presented as distorted versions of a reality the authors try to reestablish by using the same statistical tools, but in a more accurate way. They deconstruct a discourse with the goal of creating a more accurate version of the truth. Medical discourse is seen as a moral and normative enterprise pushing women to have a child at the right moment. Thus there is an opposition between two agendas, one which would relay social norms, and the other which would liberate women by unveiling how highly political and gendered the first agenda is. Showing that a part of reality – medical – is constructed, while one's own reality – social – is not, or is but in a more real way, constitutes a kind of asymmetry, which is part of the limits of a constructivist approach (Lemieux 2013). But how to create other kinds of engagement without losing a critical distance anchored in the visibility of the "social", which is the strength of social sciences? Before answering this question, I would like to turn to a second study that made me think about how to deal with social constructivism and realist essentialism.

This study is entitled "The age limit of motherhood: body, biomedicine, and politics"[16] by the historian of science Ilana Löwy (2009). The author examines the construction of the limits of reproductive age in reproductive medicine in three different national contexts: France, US, and

[16] In French: "L'âge limite de la maternité: corps, biomédecine, et politique". Translated by the author.

Israel. I will not go into the details of this very interesting and rare study on age and fertility in the context of ARTs. Instead I want to focus on the ontological status assigned to the fertility decline. By contrast with the first study presented, the author takes very seriously the reality of the fertility decline to the point that she writes that: "The problem of the age-related rapid decline of female fertility is very real"[17] (Löwy 2009: 104). Medical statistics on success rates and risks showing that aging entails more miscarriages and pathological pregnancies follow to support this point. Löwy continues her analysis by drawing a distinction between biological invariants and powerful cultural representations. The first ones include the difference between male and female fertility spans, the greater complexity of the female reproductive system, and the danger of pregnancy over 40. The second ones refer to the cultural representation of an ageless masculinity and of a femininity incompatible with aging. She contrasts these facts of life with another fact according to which women have a longer life expectancy than men. Thus the social construction of the fertility decline consists of the social selection of some biological facts instead of others, according to the differentiated cultural representation of masculinity and femininity. For example, the fact that women are infertile earlier in life, is selected and made visible socially, while the fact that women live longer than men, is never mentioned. This selective process results in the reproduction of gender inequalities.

Here ARTs and their possible role in the extension of the female fertility span are taken into account. Especially, the age-related fertility decline is taken seriously, confirming that its reality is very important in reproductive medicine. At the same time, by considering it as a fact of life, it comes before the social as a pre-given entity. To say that it is socially constructed is to say that it is socially selected instead of another fact, according to gendered cultural representations, but its nature itself remains unquestioned. This first move shows that there is nothing natural in making women's age-related fertility decline something more problematic than aging's effects on men's fertility and children's health, or than the longer life expectancy of women. But its nature is left unproblematized, thus reproducing the dichotomous vision of nature as one that is universal, enduring, stable, and passive, and of cultures as many, that are local, variable, active and possibly changing (Descola and Pálsson 1996)[18].

While this dichotomy is problematic, it is also very useful. This article allows us on the one hand to take seriously the fact that the age-related fertility decline is real, while on the other, shows that

[17] "Le problème de la diminution rapide de la fertilité féminine avec l'âge est bien réel" (Löwy 2009 : 104). Translated by the author.

[18] It is important to note that this critique is not addressed to Löwy's work in general, and is to understand only in the context of this article. Indeed, in other pieces of her work, she insists on the importance of overcoming the distinction between sex – biological – and gender – social, cultural (see Gardey and Löwy 2000).

there is nothing natural in the use of it to constitute the grounding of difference, and thus hierarchy, between men and women. Trying to go beyond the dichotomy raises thus the fear of losing something essential, something that justifies and establishes social sciences' purpose, something that enables us to fight essentialism and naturalism. Therefore the fundamental questions that underlie my work are: How to engage with the age-related fertility decline's reality, to take it seriously, because it matters so much in reproductive medicine, and to show at the same that its nature might not be so stable, or so universal, but also more active, than in the previous accounts? How to account for the reality, the materiality, and the agency of age in reproductive medicine by avoiding the pitfalls of social constructivism, as well as the traps of essentialism? How can we say that the age-related fertility decline is socially constructed, without leaving its biology unproblematized?

The detailed account of these two social sciences articles on the age-related fertility decline help to specify my own positioning as one that takes seriously the material reality and the biology of reproductive aging, that engages with and problematizes the relationships between ARTs and age, and that focuses on the multiple entanglements of nature and culture, or society. The starting point that I chose in order to do so, was a focus on the traffic between the reproductive and anti-aging sociotechnical projects (Squier 2004), traffic that is simultaneously material, technical, and epistemological.

1.2. The traffic between reproductive and anti-aging sociotechnical projects

Historically, assisted reproductive technologies and age extension strategies have more in common than might be thought at first sight. Although targeting the opposite ends of the life span, rejuvenation and reproductive technologies are originally rooted in the same project of "improving the bodily bases of human life" (Squier 2004: 148) through technological and chemical intervention that took place in the first decades of the 20th century. This can be illustrated by the experiment of the French-Russian scientist Dr. Voronoff on Nora, a mature female chimpanzee, who got pregnant with a human child after the sex organs of a human female were grafted within her. Interestingly, this experiment was performed within the framework of a larger project on gland grafting, carried out in the 1920s and 1930s, whose goal was to alleviate the symptoms of aging by grafting chimpanzee ovaries into postmenopausal women as a rejuvenation treatment (Squier 2004). In this experiment both technologies of reproduction and rejuvenation combine in a surprising way by crossing over the boundary between human and

animal, but also the boundary of the menopause separating the reproductive and non-reproductive parts of women's lives.

The "postmenopausal mother" is the striking result of this ongoing traffic between reproductive and anti-aging technologies and illustrates how some ARTs may decouple age and fertility or even subvert or "queer" motherhood (Pridmore-Brown 2009). It also indicates a shift from the original goal of "improving the human product" to the broader one of "reconfiguring the human life span" (Squier 2004: 166), as Susan Squier expresses very well: "Dedicated to blurring its [the life span] constitutive categories – those fixed biological life stages of parenthood and generationality – both projects [reproduction and age extension] may now serve a new construction of birth and aging, as exemplified in the notion of the postmenopausal mother" (2004: 166).

Contrasting this kind of account, the sociologists Bessin and Levilain (2012) criticize the common understanding that social norms regarding age and aging would become looser and give way to more individualized life trajectories so that women would have children later in life, leading them to a triple denial – biological, sociological, anthropological – encouraged by the false belief that ARTs will help them (Bessin and Levilain 2012). They insist rather that these norms still have a profound impact on the structuring of the lifespan and that the category of "older parents" is much more diverse than the figure of the "careerist woman" implies.

For my part, I am less interested in the outcome – late motherhood or postmenopausal pregnancies – than in the upstream traffic between reproductive and anti-aging technologies rendering such transformations possible. Following Moreira (2015), I think that it is crucial to examine the infrastructural processes leading to the possible reconfiguration of the life course as non-standardized and individualized. More than that, I think that it is crucial to question how age, fertility, and ARTs relate in the first place, before examining how age norms may change, because this would assume that we know what age is. Yet, I want to question what age is in relation to ARTs and fertility.

Age can be considered as a social marker used to categorize people and as a principle of social organization (Bernardi 2002; Sauvain-Dugerdil, Léridon and Mascie-Taylor 2006), but it is also more than that. I argue that age is multiple (Mol 2002) and depends on the ontological choreography (Thompson 2005) through which it is enacted. Therefore I am interested in the various ontological choreographies – scientific, clinical, narrative, biopolitical – of reproductive

aging or in other words in the multiple natures or ontologies (Mol 2002) of age in relation to ARTs and fertility. The reason is that before changing social norms and what it is to be human, "biotechnology changes what is to be biological" (Landecker 2007: 232), which means that it changes the basic components constituting human beings and therefore has an impact on how one can understand transformations of the nature of reproductive aging and of women defined by it.

While the view of a fixed pool of oocytes, declining in quantity and quality with aging, has been at the core of reproductive medicine for decades, biomedical technologies such as IVF with donated eggs and egg cryopreservation have been increasingly used to extend female fertility time and to address medically the so-called problem of "the biological clock". Along with the future regenerative possibilities opened up by the presence of germline stem cells in ovaries and by ooplasmic transfer (Woods and Tilly 2012), they have also raised the prospect of uncoupling the relationship between female fertility and age altogether, thus transforming the frontiers of age. I consider that these biomedical technologies are part of the traffic between reproductive and regenerative or anti-aging sociotechnical projects and that this traffic affects the very understanding of the category of reproductive aging and of its ontology. Therefore my questioning focuses on the productive relations between ARTs and age-related infertility and on the potentiality (Taussig, Hoeyer and Helmreich 2013) that they work as anti-aging agents in a way enabling the extension of female fertility.

Two main questions are addressed in this dissertation. On the one hand, I explore how the development and use of ARTs contribute to the production of scientific and lay knowledge on reproductive aging by opening up new possibilities of experimentally relating age and fertility and of targeting it. In other words, I focus on aspects of the traffic between reproductive and anti-aging technologies in order to highlight the conditions of possibility for ARTs to work as anti-aging and to produce knowledge on the relations between age and fertility at the same time. On the other hand, I ask how the "nature" of reproductive aging is transformed when it becomes the target of reproductive technologies and therefore how the "potentiality" (Taussig, Hoeyer and Helmreich 2013) of fertility extension is framed in the Swiss context and becomes a matter of governance.

Switzerland provides a relevant location from which to explore these questions. Indeed, this country is characterized by a strict regulation of ARTs, prohibiting reproductive treatment with donated human eggs whilst sperm donation is permitted. As this procedure is one of the main

means of extending fertility, this prohibition entails that a growing number of perimenopausal women turn to egg donation abroad to have a child and build their family. This creates specific conditions for the clinical practices of reproductive medicine and the experiences of women patients who turn to ARTs to have a child. It explains why age matters so much, as there is no medical way of overcoming it with reproductive medicine in Switzerland. The importance of age-related infertility is reinforced by the trend to delay the first childbirth: the mean age of motherhood was 31.6 in 2013 (OFS 2013) and by the age at which women start reproductive treatment, which on average is 36.3 years old in 2012 (Limoni 2014). In addition, the Swiss regulation of ARTs is based on a specific idea of "nature" in relation to what is possible without technological assistance or intervention. Consequently the possibility of extending medically fertility puts the question of "nature" and of crossing natural boundaries at the core of the debates. It explains also why this possibility has profound implications for the role and purpose of ARTs and challenges the way that the future of reproductive medicine is imagined and framed.

These elements contribute to make age-related infertility a salient medical, legal, and political issue, which is worthwhile studying because this specific context allows me to highlight the double facet of age-related infertility, as both a reality that is produced through the use of ARTs, and as something that can be transformed by them. In other words, Switzerland provides a relevant location because it allows the shedding of light on some specific conditions of possibility for ARTs to work as anti-aging in extending fertility, but also because it is a place where this potential challenges the regulatory framework, as well as clinical practices and therefore is specifically discussed.

Three theoretical axes orient this dissertation, inscribed in the fields of anthropology, science and technology studies (STS) and gender studies. To answer questions on the natures of reproductive aging, I turn to literature on "naturecultures", a term coined by Haraway (2003) and used to collapse the dichotomy between nature (body, biology, genes) and culture (nurture, education, technology) in order to suggest that "they are not two different things, but a matrix of contrasts" (Latimer and Miele 2013: 11) and that "nature cannot stand outside of culture, just as culture cannot stand outside of nature" (Latimer and Miele 2013: 11). In this respect, I turn specifically to authors who discuss ontology and materialization. As technologies play a central role in the transformations of biology, I then turn to literature on ARTs and anti-aging medicine that highlights how the dichotomy between nature and culture is blurred and transformed. Finally, as much of the discussions on the medically-assisted extension of fertility are about what these technologies might do, but also might not, about how age and fertility might be uncoupled, but

also might not, about what might change, but also might not, maybe one day in the future, I draw on literature on the governing of time and the notion of potentiality which enables me to explore the material and biopolitical effects of making something possible through biomedical technologies.

1.3. Naturescultures[19]

The idea of a fixed and immutable nature contrasting mutable cultures characterizes western modern thinking and has framed much of the development of natural and social sciences (Descola and Pálsson 1996; Hastrup 2013). While natural sciences deal with natural facts, objective reality, and things, the latter focus on social values, subjective meanings and representations. Yet this great divide has been shown to be the end-product of purification and translation processes, rather than the always-there grounding it was thought to be (Latour 1997). While ongoing efforts are made to keep things and persons, nature and society separated, the modern contract does not prevent the proliferation of hybrids crossing and blurring boundaries and categories, and deploying their agency in surprising ways (Latour 1997). This great divide has also been shown to be proper to Western thinking, as it does not tally with the ontological categories at work in other parts of the world (Descola 2005; Kohn 2013; Viveiros de Castro 1998).

Social constructivism has been very powerful in showing that things, objects, properties, bodies, identities, and categories that are taken for granted are in fact socially constructed and therefore not so stable and determining as previously assumed (Hacking 2008). A good example where the idea of social construction has been productive is in the field of feminism and gender studies. The term "gender" appeared in the 1970s (Oakley 1972) in the USA and UK in order to distinguish the biological sex, supposedly fixed, stable, and innate, from gender referring to social roles, expectations, and cultural norms (Gardey and Löwy 2000b). Separating the sex, which is thought of as biological and natural, from gender, understood as social and cultural, has been highly liberating in a first phase. Indeed, it entails that gender is variable, not natural in the sense of being fixed and determined, and thus can be actively transformed in innovative ways. In a second phase however, a side effect of this distinction, as leaving untouched and unproblematized the naturalness of the sex, as well as the alignment between sex, gender, and sexuality, has been highlighted (Butler 2006). Instead of having a pre-given fixed sex and variable

[19] I put "natures" in the plural form to stress its multiplicity and not only to challenge the dichotomous view between one nature/several cultures, but go further and challenge the idea that there is only one nature.

gender roles and expectations, sex itself has been shown to be gendered, as its biological variations escape the western binary of male and female (Gardey and Löwy 2000a; Laqueur 1992).

If biology is constructed, if nature is only social, if everything is discourse, what about the body and its materiality, critics have asked (Barad 1998; Rahman and Witz 2003) echoing two general reproaches addressed to social constructivist accounts (Hacking 2008). The first one is that they tend to assume that nature, objects, and bodies are only discursive and narrative, thus dismissing their material dimension or their reality, and possibly leading to a form of "social essentialism" (Delanda in Tuin and Dolphijn 2010). The second one is that underlying the concept of social construction, there is the notion that a similar reality can be constructed in different ways according to a different setting, temporal and spatial, but that the referential remains the same, as if there was one underlying reality that could be looked at differently from various perspectives.

To address these limits, two lines of reflection have been developed: ontology and materialization, as the question of naturecultures is inescapably enmeshed with the question of ontology and materiality. This is shown in an exemplary way by the question which the human and non-human agencies encountered in daily life have to answer, that is: "Are you objective, that is material, that is real, or are you subjective, that is probably meaningful, but unreal?"(Latour 2014: 303). Literature and debates on ontology have multiplied recently to the extent that one speaks about an "ontological turn" (Paleček and Risjord 2013; Woolgar and Lezaun 2013). A great part of the turn deals with the question of knowing whether there are other ontologies, that are other ways of thinking and experiencing the basic foundations, or reality, of one's world. In contrast, I am more interested in the question of ontology in the western modern world. Indeed, when the first approach questions the Euro-American "naturalist ontology" by putting it into perspective with other ontologies – perspectivist, animist, and totemist (Descola 2005) – STS studies have anchored the question of ontology in the practices that enact multiple realities (Law and Lien 2013; Mol 2002), as we can read in the following quotation:

> *If practices are foregrounded there is no longer a single passive object in the middle, waiting to be seen from the point of view of seemingly endless series of perspectives. Instead, objects come into being – and disappear – with the practices in which they are manipulated. And since the object of manipulation tends to differ from one practice to another, there are relations between these practices. Thus, far from necessarily falling into fragments, multiple objects tend to hang together somehow. Attending to the multiplicity of reality opens up the possibility of studying this remarkable achievement. […] This is the plot of my*

> *philosophical tale: that ontology is not given in the order of things, but that, instead, ontologies are brought into being, sustained, or allowed to wither away in common, day-to-day, sociomaterial practices (Mol 2002: 5-6).*

When ontology becomes a matter of practices, attention is drawn to the technicalities and the materialities (Mol 2002), to the "ontological choreography" (Cussins 1996; Thompson 2005), as well as to the networks and translation chains (Callon 2013; Latour and Woolgar 1996), without which a reality cannot be produced and enacted. This raises a problem discussed by Mol in her book *The Body Multiple* (2002). If ontology is enacted differently in various settings – spatial and temporal – then it entails a fragmentation of the category or the object under study into several versions that may not share any common points, that is, into plurality. Instead Mol proposes the concept of the "multiple" to highlight that the ontology of a category, entity, or object – for example anemia or atherosclerosis – may vary and goes plural, while remaining singular, or in other words, that it is "more than one, but less than many" (Mol 2002). It is not the same object seen from various angles, it is ontologically different – but the category itself remains singular – there is only one body, as well explained in the following quotation:

> *Followed while being enacted atherosclerosis multiplies – for practices are many. But the ontology that comes with equating what is with what is done is not of a pluralist kind. The manyfoldedness of objects enacted does not imply their fragmentation. Although atherosclerosis in the hospital comes in different versions, these somehow hang together. […] This, then, is what I would like the term multiple to convey: that there is manyfoldedness, but not pluralism. In the hospital the body (singular) is multiple (many). The drawing together of a diversity of objects that go by a single name involves various modes of coordination (Mol 2002: 83-84).*

Drawing attention to multiplicity thus entails a focus on the way of coordinating the several versions of an entity, to the points of conflicts, but also to the way they coexist and sometimes work together. The concept of "ontological choreography" has been coined by Charis Thompson (previously Cussins) in order to account for the coordination processes enabling the coexistence of apparently antithetical entities, in her case, objectification with subjectivity and agency:

> *I called this process of forging a functional zone of compatibility that maintains referential power between things of different kinds, ontological choreography. The choreography is the coordinated action of mainly ontologically heterogeneous actors in the service of a long range self (Cussins 1996: 600).*

Complementing this initial definition, she adds:

> *The term ontological choreography refers to the dynamic coordination of the technical, scientific, gender, emotional, legal, political, and financial aspects of ART clinics. What might appear to be an undifferentiated mess is actually a deftly balanced coming together of things that are generally considered part of different ontological orders (part of nature, part of the self, part of society). These elements have to be coordinated in highly staged ways as to get on with the task at hand: producing parents, children, and everything that is needed for their recognition as such (Thompson 2005: 8).*

Showing how ontology may be multiple depending on the practices, technicalities and materialities enacting it, as well as how agency may be distributed among human and non-human entities is a crucial first step. A parallel step is to engage with this multiplicity and study the coordination devices necessary to the coexistence of these multiple versions. In addition, a complementary step is performed by new materialism studies, which insist on the inseparability of meaning or discourse and matter. Responding to the critique of the dismissal of the reality of the body in its materiality, they try to account for the material reality of the world, while avoiding the trap of essentialism and naturalism. Or as Coole and Frost (2010) write, the "challenge is to give materiality its due while recognizing its plural dimensions and its complex contingent modes of appearing" (Coole and Frost 2010: 27). Instead of essentializing matter, these authors try to go beyond the dichotomy between the biological and the social by showing how matter which is usually thought of as passive, inert, and stable, is more contingent and relational, but also more active and dynamic.

New materialism thinking is much influenced by scientific developments in physics, molecular biology, and epigenetics, making it impossible any longer to think about matter in a simple way. Instead of comprehending matter as an essentialized, well-delimited substance, these scientific works encourage us to comprehend it as "forces, energies, and intensities" (Coole and Frost 2010: 12), and as "open, complex systems with porous boundaries" (Coole and Frost 2010: 15), and blurring clear distinctions between bodies, objects and environment. An important effect of these new understandings of matter is that it entails a focus on material-discursive phenomena (Barad 2007) assuming that there is an ontological inseparability of the properties of objects from their observation, or the apparatus they are known through. In addition, the complex entanglements of matter and meanings entail a redistribution of agency, as the active force of mattering processes is increasingly recognized.

1.4. Reproductive and anti-aging technologies

Reproductive and anti-aging technologies are two sites where nature and culture transformations are particularly visible. By definition, technology materializes the human intervention on nature, whether in agriculture or in bioscience and biomedicine. It is part of a history where tools and techniques have been developed by humankind to control, benefit from, and exploit natural resources (Franklin 2013a). In the life sciences, similar processes are at work, as life itself becomes something that can be controlled, reengineered, and capitalized. Especially the development of contemporary biomedicine with its molecular and genetic tools, entails a molecularization of life, defined as:

> *The "style of thought" of contemporary biomedicine envisages life at the molecular level, as a set of intelligible vital mechanisms among molecular entities that can be identified, isolated, manipulated, mobilized, recombined, in new practices of intervention, which are no longer constrained by the apparent normativity of a natural vital order (Rose 2007: 5-6).*

As reproduction and aging are at the core of the two crucial events of human life that are birth and death, they constitute two crucial sites to examine closely in order to understand how technology is at work in this "remaking of life and death" (Franklin and Lock 2001; see also Kaufman and Morgan 2005), or "remaking of the biological" (Franklin 2013a).

Since the birth of the first test-tube baby in 1978 in UK and the social studies on ARTs that followed, the question of nature and of biology has been central. Marilyn Strathern highlights how the connections made between one domain and another are shifting, and describes how in medically assisted reproduction, nature loses its grounding function as it becomes assisted (Strathern 1992b). The destabilization of nature has been particularly visible and studied in the domain of kinship which provides a powerful model to think about the nature-culture dichotomy. Indeed, it can be read as the social construction of natural facts, in the sense of a model built from the facts of life, or in Strathern's words: "Kinship as a whole can be represented as a natural domain based on immutable relations as against the rest of society, or in the way that kin arranged their relationships, we might discern within the domain of kinship both what could not be changed (a natural element) and what could be (an artificial one)" (Strathern 1992b: 53).

ARTs trouble the western model of kinship based on the sharing of biological substance and the transmission of genes (Schneider 1984) by opening up the making of a child to other persons, such as egg or sperm donors and surrogates. The division in motherhood and fatherhood

functions that this entails, much studied in the literature (e.g. Freeman et al. 2014; Konrad 2005; Orobitg and Salazar 2005; Porqueres i Gené 2009) leads to "strategic naturalization" processes (Thompson 2005: 145-178). As the basic components of the facts of life are transformed, this has effects not only on the way kinship in the sense of the nuclear family is thought, but more broadly on the ways the Euro-American genealogical model (Bamford and Leach 2009), still salient in many areas of science and of our lives, frames "understandings of race, personhood, ethnicity, property relations, and the relationship between human beings and nonhuman species" (Bamford and Leach 2009: 2).

However, IVF not only troubles the nature of kinship and gender categories, it participates also in a broader movement of "dissolution of the biological and technical […] "through which biology is not only denaturalized, but 'cultured up'" (Franklin 2013a: 4) as it expands in a platform reuniting stem cells research, regenerative medicine and cloning techniques. Instead of remaining this untouched, fixed and stable ground, biology itself becomes technology (Franklin 2013a). Biology becomes the tool enabling the reengineering of life, blurring the distinction between cause and effect, agency and passivity, as it is both what is determined by human intervention, and what determines it (Franklin 2013a).

Not dissociable from the powerful ideas of hope and progress, Franklin shows how the idiom of frontier, as a zone of hybridity, is useful to think about this interplay between technology understood as culture, and biology understood as nature. In her last book, *Biological Relatives* (Franklin 2013a), she continues her exploration of the notion of frontier started in *Dolly Mixtures* (Franklin 2007), and traces its cultural and technical history. She follows the material and symbolic dimensions of the notion of frontier, in relation to colonialism, settlement, and appropriation of new unknown lands, but also as an idea, a concept, an idiom, as in the frontiers of science or the idea of new biological frontiers. The frontier is a border, a limit, a line, a place of opposition between an inside and an outside, but also, she insists, the place of their continuous mixing, interpenetration, hybridity, oscillation, and instability. She highlights the temporal dimension of the frontier as something grounded in the past but also as a space laying ahead, in the future, opening up a set of possibilities. As an "analogy for conversion" as she calls it, the notion of frontier allows us to grasp the processes through which what is unknown becomes known, or what was beyond the "merely real", becomes the "regular real", and thus naturalise and normalise new relationships.

By focusing on the inherent hybridity of the frontier, Franklin shows how ambivalence is at the core of these transformations, in the sense that biology becomes increasingly mutable, while ARTs contribute also to reproduce kinship and gender models. ARTs are profoundly ambivalent or paradoxical (Franklin 2013b; McKinnon 2015) in the sense that by imitating nature they transform it, but they also reproduce categories and relations that are the same, and yet not exactly the same. As Franklin writes, "IVF can be described as both debiologising and rebiologising, offering a version of biology that is bespoke, artificial, controllable, personalized, and redesignable, while also providing essentially the 'same' route to conception, pregnancy, and parenthood as that naturally experienced by fertile couples" (Franklin 2013a: 239).

Similar processes are at work in the domain of aging, as anti-aging or regenerative biotechnologies – ranging from the classical hormone replacement therapy (HRT), Viagra, the so-called hormone of youth DHEA, to the developing fields of stem-cells, nanobiology, and gene therapy – increasingly target the process of aging at a cellular level. This has profound effects on the categories of aging, as death becomes cellular (Landecker 2001) and aging, a "disease or an accident that can be avoided thanks to control and safety devices" (Lafontaine 2009: 54), that is a "risk category" (Cardona 2008; Rose 2001). By aiming at controlling the molecular and cellular processes underlying aging, these technologies blur the distinction between the normal and the pathological (Canguilhem 1966; Katz and Marshall 2004). In anti-aging medicine, it is not that aging becomes an illness that is to be cured, but that life itself can be regenerated and enhanced, or optimized (Mykytyn 2008).

Exploring the construction of the category of "natural" in anti-aging medicine, Mykytyn (2008) shows how the category of the optimal – rather than prevention, treatment, or disease – becomes central, entailing that to know whether aging is natural or not is no longer relevant, as aging is considered to be natural, but can be optimized. She describes also how a reversal is at work, as it is the human intervention in the nature of aging that is naturalized as the hallmark of humanity, and not the irreversibility and ineluctability of the aging process, as one can read in the following quotation:

> *However, in the context of anti-aging, it does not appear that nature is imploding or collapsing; rather nature is being reanimated at the locus of the human drive for liberation. Practitioners argue that anti-aging pursuits are fundamentally natural in that it is more natural to seek deliverance from our biological constraints (Mykytyn 2008: 318).*

Studying the negotiations of nature, society and anti-aging technologies, Katz and Marshall (2004) explore the effects of making age functional. Focusing on the "function" of organs contributes to blurring the distinctions between natural, normal, and pathological processes. It entails also a distinction between functional age, objectified through biomarkers, and chronological age. Locating age in bodily functions permits to some extent to de-essentialize chronological age, but also entails that cultural values and norms gain in importance and take the place left by a malleable and plastic nature: "The natural to the extent that it still functions as a sign of ontological existence is increasingly culturalized and open to cultural experimental forces" (Katz and Marshall 2004: 54), and by claiming to liberate us from biology, "yet push our cultural values right back onto our body's functions, hormones, brains, and faces" (Katz and Gish 2015: 56).

1.5. Temporalities and potentialities

Both reproductive and anti-aging or regenerative technologies are technologies of hope and progress as shown by the idiom of frontier characterized by the constant pushing of biological limits in the name of the discovery of new territories and new possibilities. Much of the scientific work in these fields is indeed performed in the name of future promises such as having a child or improving or extending life. Following Brown, we can say that "technological change is therefore a process of constant oscillation between present and future tenses, between present and future solutions" (Brown 2003: 6). The tension between the present time and future possibilities impacting already on the present brings the issue of temporality to the fore. According to Gibbon, "time itself [is] a category to be examined in life science" (Gibbon 2013) and it has recently been increasingly studied in relation to bioscience, biomedicine, and biotechnologies, but especially regarding their modes of governance. As the future carries with it promises, hopes, uncertainties, and fears, the issue of potentiality is problematized in association with it. Therefore, these two axes of theoretical reflection become intermingled.

Adams, Murphy and Clarke (2009) characterize the current period by the central notion of "anticipation" where the future, or the domain of the not-yet, determines the present and the way one lives in it. Characterized by an inherent uncertainty, techniques making it knowable expand. These "anticipatory modes enable the production of possible futures that are lived and felt in the present, rendering hope and fear as important political vectors" (Adams, Murphy and Clarke 2009: 248). As the future is necessarily coming, it demands action in the present giving a certain weight to moral authorities in charge of anticipating the future, but also to individual responsibility, as one becomes in charge of one's fate that has to be anticipated properly in order

for things to be all right. Anticipatory regimes also work in the present, in that they entail new kinds of engagement with possibility and reconfigure the sense of what is possible (Adams, Murphy and Clarke 2009).

Focusing more specifically on biomedicine, Lochlann Jain and Kaufman (2011) show that we live in a time "after progress" where futures are constantly brought back into the present through imaginings and promises. They insist that the way the future is imagined and lived in medical spaces has effects in the present, in the sense that it determines who should have a future and what kind of future is available and desirable. Focusing on aging society, Kaufman and Fjord (2011) define progress as the "long-held enlightenment idea that rationality and its tools can unequivocally improve life and reduce suffering" (Kaufman and Fjord 2011: 213). In contrast, the notion of "after progress" "critically reflects on the priority and effects of even more technology use in an aging society" and on the new hierarchies, economies of responsibility, and moral imperatives which this may bring with it as "technical ability and success become ethical necessity" (Kaufman and Fjord 2011: 213).

In a programmatic introduction to a *Current Anthropology* special issue on "potentiality and humanness" (Taussig, Hoeyer and Helmreich 2013), anthropologists and science studies scholars propose to put the notion of potentiality at the centre of the analysis. Tracing its etymological and historical roots, they make a first attempt at unpacking and defining the notion, which can be used both as an analytical concept, and as an empirical object. They identify three meanings attached to the term. The first one refers back to the Aristotelian notion of potential as a hidden force determined to manifest itself, and which has its future built into it, raising the spectre of essentialist assumptions. The second one refers to the capacity to transmute into something completely different, to a genuine plasticity, as shown in the example of stem cells. Finally, the third one refers to a latent possibility imagined as open to choice, a quality available to human modification and agency (Taussig, Hoeyer and Helmreich 2013: S4). It must be noted that the three meanings can be attached to the same object and are not mutually exclusive.

Going back to its etymological root in the word "power", Taussig, Hoeyer and Helmreich (2013) stress the political dimension of potentiality and show how naming or framing something in terms of potentiality has to do with what we think can, should, or might be changed, modified, transformed by human agency, reflecting in this way its own moral and political order. It thus falls within the scope of biopolitics or the power over life (Andrieu 2004; Foucault 1976; Rabinow and Rose 2006; Rose 2001). Temporality and imagination are two crucial aspects of

potentiality, thus becoming elements at the core of the politics of life: "Potentiality indexes a gap between what is and what might, could, or even should be. Such a gap opens up an imaginative space of magic and mystery in which future-building activities related to animating bodies and extending life in new ways loom large" (Taussig, Hoeyer and Helmreich 2013: S5). The way in which imagining the future determines the present is therefore always political in the sense that it paves the way for desirable futures, while foreclosing others.

Studies focusing more on the temporality of promises and expectations analyse how the future is brought into the present through various modes, from risk assessment strategies to preparedness regimes and event technologies (Samimian-Darash 2013). The sociology of expectations (Brown 2005) especially focuses on temporality and imagination, highlighting the performativity of futures which are "available to us through imagination and representation" but are also "scripted in the present's materiality" (Brown 2003: 11). Contrasting regimes of truth with regimes of hope (Moreira and Palladino 2005), Brown (2005) shows how "possibility spaces serve as a means of enrolment but also as protected zones in which future possibilities are given greater weight than the perhaps less promising realities of present truths" (Brown 2005: 335-336). It echoes Thompson's work on promissory capital, a notion referring to the future-oriented dimension of a biomedical mode of reproduction which "represents a change in the temporal dimension that is relevant to assigning economic value – a shift from the primary dimension being the past and present to its being something that unfolds over time in the future" (Thompson 2005: 258). Even though the future remains by definition unknown and uncertain, Brown encourages us to look at how the future is materially brought back into the present, or in the "ways in which imagination becomes materially or corporeally embedded in bodies, structures, routines, systems, matters, etc. that they assume a future reality status in the present though often not" (Brown 2005: 353).

1.6. Scientific, experiential, and biopolitical routes

The dissertation is divided into three parts. The first one is entitled "From age to aging: the science of reproductive aging and its frontiers" and focuses on the science of reproductive aging. The second part, "Living age/aging: reproductive medicine and the experiences of age and aging" turns to the clinic and focuses on the experiences of patients of the age-related fertility decline and of the possible intervention of ARTs to overcome it. The third part, "Age limits: imagining and regulating the future of reproduction" addresses the biopolitics at stake in the possible role of some ARTs as anti-aging and focuses on the discussions among medical experts. The structure is not linear. Each part can rather be read as adding a layer of complexity to the other ones, and

entails a re-reading of them. As in a spiral, each part echoes the others, and while some aspects might look like a repetition, the description of their enactment in other practices complicates their understanding. Each part can be read separately, but reading them together will deepen the understanding of the multiple natures of the age-related fertility decline and of its relationship with ARTs.

The first part explores the making of the scientific evidence of the age-related fertility decline and highlights how the traffic between reproductive and regenerative sociotechnical projects is necessary to the production of scientific knowledge on reproductive aging. Chapter 3 deals with the statistical evidence of age-related infertility and the efforts of demographers and epidemiologists to isolate the impact of "age alone" from other variables considered as bias. It documents their search for a "natural" fertility decline able to be used as a basis of comparison with other fertility patterns, and sheds light on the role that sperm donation programs and IVF played in it. Chapter 4 focuses on the emergence of the category of "ovarian aging" and on the role of "egg donation" as an *in vivo* model enabling the location of age in the oocytes and making their "quality" a crucial site for research. It highlights the centrality of transfer as a tool necessary to the making of ovarian aging. Chapter 5 closes this part by examining the controversy about the possible ongoing production of oocytes in adult women in contrast to the idea that they are born with a finite pool of oocytes. It highlights how by trying to understand oogenesis, reproductive biologists transform the "nature" of age and participate in the uncoupling of chronological and biological age (Moreira 2015). This chapter especially sheds light on the increase in the traffic between reproductive and regenerative sociotechnical projects, as reproductive aging becomes a matter of "aging only".

The second part moves to the clinic and examines the ambivalence of the traffic between reproductive and anti-aging sociotechnical projects in women's and couple's experiences by analysing the emergence of the materialdiscursive frontiers of age. If the postmenopausal mother is the striking result of this traffic, I argue that it is much more extended and that it has effects in a more ordinary way on the definitions, understandings and experiences of the frontiers of age. Thus Chapter 6 describes the materialization of age – ovarian, hormonal, statistical, as a resisting force – in the framework of reproductive medicine and traces the various apparatuses through which it "gets real" (Barad 1998), such as hormone levels in the blood, oocytes on an ultrasound screen, and success rates. Chapter 7 especially highlights the specific temporality of ARTs treatment and the importance of the calibrating of time (Thompson 2005). It argues that in this specific temporality, reproductive treatment cycles contribute to the "getting real" of age as a

matter of time. Finally, Chapter 8 is interested in the way in which women turning to egg donation in their forties draw on the distinction between biological and chronological age to transform the age limits of motherhood (Löwy 2009).

The third and last part engages more specifically with the anthropology of potentiality (Taussig, Hoeyer and Helmreich 2013) and questions the biopolitics of the traffic between reproductive and anti-aging projects. It examines how various potentialities are produced and how they articulate with different kind of futures in relation to egg donation and freezing in Switzerland. It addresses the politics and economies of potentiality in the Swiss context, and especially the central role of the regulation on ARTs in their production and shaping. Which elements – cells, bodies, technologies, groups of people – are seen as carrying potential, and how hope, uncertainties, and ambivalence articulate with these various potentialities are the questions addressed in this part. Chapter 9 shows how both egg donation and egg freezing are inscribed in a regime of cautiousness, revealing how the future of kinship and gender relations is associated with both utopian and dystopian futures, where the individual moral responsibility of women is especially put to the fore. Finally, Chapter 10 explores how reproductive medicine physicians negotiate the potential anti-aging dimension of ARTs and the associated possible transformation of the nature of reproductive aging, and questions what is at stake in their efforts to maintain a boundary between "normal" and "pathological".

2. How age has become a question

When I started fieldwork on the making of family through ARTs in Switzerland, I found age everywhere. In women's narratives and experiences where it is the fear of having waited too long, but also the hope to be on the good side of the statistics, the hope for a happy family, the hope that ARTs could actually do something about it. Where it materializes in bodies under the form of miscarriages and treatment failures. Where it is something one does not feel as long as one does not want a child, something that is the problem of doctors, but that may become very personal when it implies renouncing the passing on of one's own genes. I found age in clinicians' practices, where the biological norms of reproductive aging are used to take decisions about treatment options, where statistics correlating success rates with age are presented to patients, where the number of follicles on an ultra-sound screen, and the level of FSH[20] on day 3 of the cycle become crucial markers of the ovarian reserve. In the media also, where post-menopausal pregnancies through reproductive treatment with donated eggs are highly debated and raise fears about intergenerational confusion, the wellbeing of the child, and the troubling of a "normal" and "natural" lifespan. In the Swiss regulations finally, where egg donation – which is one of the main means of extending fertility, along with the more recent possibility of autocryopreserving oocytes – is prohibited, entailing that older women have to cross national borders in order to access reproductive treatment with donated eggs.

At the same time an object of discourse and practices, a measure and an inner feeling related to the most intimate experience as well as to the most mediatized stories, age was saturated with values, affects, ethics, politics, gender, and figures of all sorts, that seemed relevant to examine from a socio-anthropological perspective. How to account for these multiple dimensions and scales? How to account for their complexity (Law 2004; Law and Mol 2002)? How to go beyond the apparent obviousness of age? After all, everybody knows what age is. Furthermore, is age itself the subject of the inquiry or rather just a starting point that enables the understanding of several dimensions of reproductive medicine in Switzerland? These are some of the questions that made me think along the research process. Trained as an anthropologist, I felt armed, at least to some extent, with knowledge and skills to face this challenge, as by definition social and cultural anthropologists are used to dealing with various levels and scales, and with the "thickness" (Geertz 1994) of their object of study. In addition, I could draw on the tools developed by the social studies of science and technology (STS) to grasp the multiple

[20] FSH is the Follicle Stimulating Hormone, secreted by the pituitary gland. One of its roles in women is to stimulate the growth of follicles. Its level varies during the menstrual cycle. FSH test is usually performed on D3 of the menstrual cycle. FSH is also used as a drug to stimulate the ovulation (e.g. Vulliemoz et al. 2006; see also the glossary in Appendix 1).

ramifications, complexities, and ontologies of scientific objects as they are produced, circulate, and transform (Law 2004). But I was not prepared for the long detours, for the sense of being lost, of not knowing, of not seeing, that I would go through on my long journey to finish this dissertation.

This chapter is about the "mess" (Law 2004) of the research process by which age has become the question for me to explore. It is about the way that I followed age in several sites, sometimes unexpected, about the crucial crossroads I encountered, and the road signs that helped me to stay the course. The goal is to present the main methodological assumptions, rules and tools, mobilized and underlying the research process, or in other words marking out my road on the tracks of age. I will first show how I gained access to fieldwork and how it determined my project. I will then explain how age has become the question to explore and finish with some reflections about my own situatedness, and the inevitable partiality of my account, as it is a condition of qualitative research (Jensen and Lauritsen 2005). But before going into the account of my research journey, I would like to start by giving a synthetic insight of the research process.

2.1. Starting with the end-product

Here is a synthetic description of my research process that can be read rather as its end-product than its starting point. It will give the reader a general overview of the work done in a way similar to what could be found in a published article, leaving the uncertainties, doubts, and choices hidden. So! This dissertation is based on data collected in the framework of the project "Fertility and Family in Switzerland: Local Processes of Reproduction and Kinship in Transnational Contexts of Biomedical Technologies", directed by Prof. Willemijn de Jong (Department of Social Anthropology and Cultural Studies, ISEK, University of Zurich) and funded by the Swiss National Science Foundation (SNSF) (2010-2013). My project adopts a new materialist[21] stance, inspired by STS and by gender studies (e.g. Fraser 2002; Tuin and Dolphijn 2010). Methodologically, it conjugates qualitative empirical-observational method associated with a multi-sited ethnography (Hine 2007; Marcus 1995) and tools developed in situational analysis (Clarke 2003; Clarke and Friese 2007). The analysis draws on three main types of material collected between 2011 and 2014: 1) 48 ethnographic interviews (Beaud and Weber 2003; Sherman Heyl 2001) with 34 women or couples undergoing reproductive treatment and 21 with clinicians and other experts – psychologists, bioethicists, intermediaries who help people to go

[21] The appellation "new materialism" is controversial and I agree that the "new" is not relevant (see Ahmed 2008 ; Davis 2009 ; Van der Tuin 2008). However I use it, to distinguish it from a materialist feminism approach inspired by Marxism.

abroad for treatment, legal and public health experts – all involved in the field of reproductive medicine; 2) observations during interviews, conferences, information sessions, and through regular contacts with a reproductive medicine unit; 3) a corpus of scientific and medical articles collected though the data bases PubMed, Web of Science and Google Scholar, as well as legal and media texts relevant to the Swiss context. All identifying information was removed or substituted in order to provide the informants with anonymity[22]. The approval of the ethical commission of the hospital I collaborated with was obtained in September 2011 and the patients recruited there signed an informed consent form.

While providing important information about the data analysed, this short account does not say much about the research process itself, about how I got access to the fieldwork, how the limits of the fieldwork were drawn, who I met, and how I talked to them. Following the reflexive tradition characterizing ethnographic, gender and STS approaches since "Writing Culture" (Clifford and Marcus 1986) and its reflexive turn, I am going to highlight these moments left otherwise in the dark, without going into a self-confession in order to save objectivity (Jensen and Lauritsen 2005), but rather with the goal of giving a sense of the partial connections (Haraway 1991b; Strathern 2005) in which I found myself engaged.

2.2. Finding people

Gaining access to the field is a crucial and determining phase of the research process (Beaud and Weber 2003). It reveals much about how the ethnographer is perceived and the role he/she is assigned to, but also says much about the crucial characteristics of the object, people and relationships under study. In addition, it is crucial as it determines the continuation of the research process by opening up some spaces whilst closing others, and by enabling the establishment of some relations, while cutting others apart. There is a strong tradition in anthropology and in STS for conducting ethnographic long-term *in situ* fieldwork, in STS known as "lab studies" (Hess 2001). However researchers have gone out of the lab and have started to turn to multi-sited approaches, less bounded in space and combining different kinds of material (see e.g. Franklin and Roberts 2006; Rapp 2000; Thompson 2005). This has led them to develop critical understandings of the notion of "site" and to propose new concepts able to account for this move "outside the citadel of expert knowledge to the viewpoints of lay groups, activists, social movements, the media and popular culture" (Hess 2001). As lab studies, and classical ethnographic studies, are characterized by "face-to-face encounters"(Beaulieu, Scharnhorst and

[22] All names of people met in the fieldwork are pseudonyms. Only when published papers are cited, are real names mentioned.

Wouters 2007), new understandings of field sites are developed, and concepts such as "co-presence" and "focale" instead of "co-location" and "locale" have been coined to account for the flow and pace characterizing research out of the well-defined space of the lab (Beaulieu 2010; Beaulieu, Scharnhorst and Wouters 2007). Co-presence is considered as an achievement that can be established through a variety of modes with the advantage that it "decentralizes the notion of space [and of physical co-location] without excluding it" (Beaulieu 2010: 454).

In line with these developments, my fieldwork did not take place in a bounded space where I would have stayed for a long time. Researching "at home" (Madden 1999), what characterizes it instead, is the fluidity of my presences-absences and the development of several ways of being co-present. But if there is no site where to go in and from which to go out, where to start? Where should a threshold marking the access to the field be crossed over when the boundaries between daily life, professional life, and the more or less virtual space of fieldwork are not clear-cut? What is access when there is no delimited site to access? "Talking to people" (Madden 2010) seemed a good first strategy in order to achieve co-presence and, for a start, I answered these questions by looking for several sites – physical and digital – where I might find people supposedly concerned with ARTs.

My task in the project "Fertility and Family in Switzerland" was initially to explore the efforts to build and continue one's own family through ARTs in the French speaking part of Switzerland with a focus on heterosexual couples and on intergenerational relations[23]. One challenge was to study these processes of family building outside of the reproductive medicine unit. With this goal in mind, I started to look for heterosexual involuntary childless people undergoing or having undergone reproductive treatment in order to have children and build their family. Where to find them? I was not driven by a sample logic and did not have any representative goal (Madden 2010). In Switzerland, the regulations prohibit access to ARTs by single women, and by same-sex couples[24]. That means that all people undergoing ARTs in the country are assumed to be in heterosexual relationships. In other words, just looking for people turning to IVF in Switzerland meant that they were in the target group of the research project.

The first and spontaneous means that I used to meet those people was my personal contacts. I started to talk about my research project around me, in my friends and family circle, saying that I was interested in meeting people who had undergone IVF or insemination to have children, or

[23] The initial research project was divided into three parts. In addition to my part, Dr. Kathrin Zehnder (see e.g. Zehnder 2014) dealt with male infertility and sperm donation, while Yv Nay focused on LGBTQ family building (see e.g. Nay 2013; Nay 2015).
[24] See Appendix 2 for more information on the legal regulation of ARTs.

who were currently undergoing treatment. Friends or colleagues often knew persons who might be interested in participating, to the extent that I had the feeling that everybody around me knew somebody who had gone through IVF to have a child, or who was going to do so. This in itself can already be read as the sign of an increased "normalization" and "naturalization" (Thompson 2005) of IVF. They generally gave me the phone number or the email address of the persons interested in participating in the research so that I could contact them personally. Following the snowball principle (Atkinson and Flint 2001) I ended up meeting a third of the participants through this means.

Mostly they had already ended their treatment, with or without a child, and were happy to look back retrospectively at their experience. I was the person who entered the intimacy and privacy of their homes and narratives, was shown pictures and was offered tea and coffee. Instead of neutralizing my presence as is necessary in the lab or the clinic, my coming created the event. It was a moment cut off from daily life. Often both partners organized their schedules in order to meet me, and sometimes it even provided them with the opportunity to speak to the child/ren about the way they were conceived, making from the interview an event marking out their family life. What made my presence acceptable was precisely that it was exceptional in the sense of being separated from daily life both relationally and practically. Another element was the careful and respectful listening to the often painful experiences these people had been through, that characterizes "ethnographic interviewing" (Sherman Heyl 2001).

But where were the people turning to ARTs besides my personal network? Another site where I found them is an Internet forum based in the French speaking part of Switzerland and dedicated to pregnancy, motherhood, and family issues, including more specifically a line of discussion on infertility and reproductive medicine. While there are several online forums, I found this one especially interesting because it was very active, in the sense that many people wrote under pseudonyms on a regular basis and interacted with each other. When I started my research it provided me with an insight into the experiences of women[25] undergoing reproductive treatment, the questions they had, the difficulties they faced, their doubts, hopes, pains, and joys. In this way I collected many stories and lines of discussion on the topic of ARTs. It was strange to access such intimate topics while not knowing the persons, and without them knowing that I was reading their stories. The forum thus creates a specific mixture between making public the most intimate and keeping secret the most public. Anonymity and thus the fact that women will *a priori*

[25] *A priori* mostly women write in this line of discussion.

never know each other is precisely what enables the existence of this "digital biosociality" (Hagen 2010).

After many weeks of reading and collecting some threads of discussion, I thought of it as a way of meeting people. I created an account and presented myself saying that I was an ethnographer working in a research project where we tried to understand the journeys and the experiences of people turning to ARTs to have children. I had noticed before that I was not the first one to use this forum to contact people or do research. Especially I had noticed that several journalists had used it to find people willing to tell their stories. Another thing I had noticed was the emotional tone of the discussion. The forum was used as a way of accessing information about treatment, but above all, it appeared to me, as a way also of expressing the feelings, the pains, the disappointments, the anger, the injustice that the women could not express in other settings. So the challenge for me when I wrote this first message was to appear professional, in a sense that women could trust that it was serious research, the SNSF[26] funding working here as a guarantee, but on the other hand that they could feel that I was close enough to them by using the same kind of emotional tone. The research was somehow implicitly presented as an alternative space to the forum where these women could express themselves and tell their painful stories, and get some recognition from the outside, firstly through the interview, but also implicitly more publicly through the future publication and dissemination of the results. It worked well and within a few days I had already received several messages from people active in the forum and willing to share their stories with me. An exchange of messages online usually occurred at the beginning, sometimes they had more questions about the research, but usually, we quickly got into details, such as where and when to meet in person.

Most of the contacts resulted in face-to-face meetings, but some contacts also remained online. For example, I had a long discussion with a woman very active in the forum, who was disabled and whose access to ARTs in Switzerland was refused. I planned several times to meet her but never managed to, as her need for secrecy was too strong. Another couple turning to egg donation in a foreign country answered first positively and then changed their minds, as they already had told their story on TV and they wanted to recover some privacy. Another person was very active. She was the mother of an infertile woman, and like the "godmother" of the forum, always providing encouragement, nice words, reassuring information, and crossing fingers for all the women undergoing ARTs. I found it very interesting that she was so intensely involved and I contacted her. She did not want to meet but agreed to answer my questions online via the forum.

[26] SNSF is the Swiss National Science Foundation.

These examples point to the need for privacy of some people who were happy to confide within the frame of anonymous relations, but did not have enough interest in the research to meet me in person. It points also to infertility as a zone of vulnerability that people do not necessarily want to expose even though they may express anger and resentment as the first case, and a need to express themselves. However most of them answered positively and I was able to meet a third of the participants through this means. It was especially useful when I decided to contact women undergoing egg donation. The procedure being prohibited in Switzerland, the anonymity of the forum provided me with a unique means of meeting people who had turned to it abroad and whom I would not have met through the hospital recruitment.

Revealing my status is the way I positioned myself on the forum and was identified by others. On the one hand, I never intervened as a participant. I did not feel that I was entitled to, because I was not facing infertility myself and what I knew about the subject came from other people. This is suggestive about how the expertise which entitles one to express and participate in the forum is based only on one's own personal experience. On the other hand, the public dimension of the forum led to me being contacted later during the project by a journalist who was preparing a documentary and had seen my call for participants in the forum. This indicates how in spite of my external position, I could be identified through this means and I had become part of the broader picture myself.

Another key moment in my gaining access to a fieldwork taking shape slowly was the passage through the ethics committee of a hospital. In my search to meet persons undergoing reproductive treatment, of course the clinical settings seemed very appropriate. I contacted the chief doctor of the reproductive medicine unit of a hospital[27] who answered quickly and courteously my request for an appointment. The reproductive medicine unit is located in the same building as the maternity unit, which is apart from the main building where all kinds of other acute care services are located. After being mistaken for a patient by the receptionist, I had to wait in the special space reserved to the head doctor's patients. After a few minutes, she invited me to come in to her office. She wore a white coat and invited me to be seated face to face. I started to describe my project, and the doctor immediately engaged in discussion, providing me with much important information. When I introduced my request to meet people undergoing treatment she was at first very open to it and said that there was no problem, but at

[27] It has to be noted that in the French part of Switzerland there are only two important centres for reproductive medicine, one private and the other one public. Besides these two big centres, there are many private practitioners working in collaboration with clinics often having a patient group with infertility problems and a patient group in general gynaecology-obstetrics. In addition to the big public centre in the University Hospital, several satellite clinics were open in smaller public hospitals during my fieldwork.

the end of our discussion, she said that actually I had probably to undergo the ethical procedure, as it was not possible to access patients without the approval of the ethical committee.

Once this point was confirmed, I wrote a first proposal for the ethics committee presenting the objectives and questions of my research and prepared an information letter intended for potential participants, presenting the project and especially giving information about the interview process, what was expected from them and what they had to gain by participating. My proposal was not accepted at the first submission and I was asked to give more details about the methods, as well as an ethical aspect concerning the way I would deal with the possible presence of children during interviews. This reveals the tension between two frames of reference for doing research, one medical and quantitative, and the other a social sciences one, which is qualitative and adopts a rather open and inductive stance. After the proposal was accepted in September 2011, I had to discuss the practical details of the "recruitment" process with the doctor. It was decided that the medical team would recruit the patients and would give me their phone numbers or email addresses, in order for me to contact them.

As participant observation in the clinic was not part of the initial research project, my contacts with the medical team were made through two days of observation in the unit, and arranged meetings when I went to the clinic for the nurse to give me the references of the patients willing to participate. Through this means I ended up meeting the remaining third of patients. Going to the clinic was always an interesting time of discussion and slowly some relations with members of the staff developed. I also attended special events such as information sessions, conferences, and a scientific café, where I would meet some of them.

In order for me to understand the medical dimension of the experience of infertility I also decided to contact medical experts, as well as an ethicist, legal experts, psychologists, and "reproductive tourism" experts, in order for me to grasp the multiple facets of turning to ART's in Switzerland. The approval of the ethics committee helped me to meet them. It gave another guarantee of the "quality" and "validity" of my project in the eyes of doctors and experts. In addition, my access was facilitated by the expertise that I gained by meeting women, couples, patients, and especially those turning to egg donation cases, as it is a prohibited and thus a rare procedure. Along with the ethical approval, it worked as a guarantee of the quality and interest of my work.

In short, gaining access was performed through multiple "entrance" points, characterized by moves of presence and absence, continuities and discontinuities, and through the slow identification of myself as the researcher working on the social dimension of ARTs, as well as the spokesperson of women's voices. Instead of being identified by my long-term presence, I remained "the other", coming from outside, both to patients and doctors and circulating between these several worlds. While it prevented me from studying the richness of clinical practices and raised the fear of a loss of depth (Hine 2007; Marcus 1995), my moving among different "social worlds/arenas" (Clarke and Friese 2007) forced me to work on the intensity of my presence (Beaulieu 2010), rather than on its duration. This approach was specifically relevant to study the multiple ontologies (Mol 2002) of age. In addition, it forced me to always put a "world" into perspective with another, and this switching back and forth was especially fruitful for seizing the complexities of age in relation to ARTs.

2.3. When age emerges as a question

Characterizing the ethnographic approach is its inductive and open-ended dimension, entailing that there is no clear temporal nor epistemological separation between data collection and analysis. Instead, research advances through an ongoing process of switching back and forth between empirical observations and readings, findings and elaboration of concepts and theory, collection, organization and analysis of the various data (Beaud and Weber 2003; Madden 2010), very similar to grounded theory's principles (Bryant and Charmaz 2007; Clarke and Friese 2007; Corbin and Strauss 1990). The aim of this section is to present crucial moments in the construction of fieldwork that shaped the object under study. As described above, when I started the research I wanted to talk to people undergoing ARTs, but left their possible specification open to the construction by the research process. However at the time of my collaboration with the medical unit, I asked them to put me in contact especially with older women. Similarly, on the forum, I ended up looking for women undergoing reproductive treatment with donated eggs and/or facing age-related infertility. What happened in between to explain this choice? The answer is that I started to be interested in "the question of age". What follows is about this question, the way I became interested in it, and the way in which it became the question at the core of my research.

2.3.1. First interviews and observations

As often happens in ethnographic – or more generally in qualitative – research, the first interviews and meetings with people are decisive (Beaud and Weber 2003). In all of them and for various reasons, age and time were thematized in a way that caught my interest as indicating that age could take many forms, but was also a transversal object revealing key aspects of the experience of infertility.

Jasmine

The first woman I met, Jasmine, was one of my personal contacts. At the birth of her second child, commenting on the short age gap between her children, she had told me that they had been conceived with the help of IVF. When I started doing fieldwork on ARTs, she was among the first person I thought of as possibly interested in participating. She actually answered my request positively. She proposed that we meet on a playground with our respective children. The discussion was not recorded, kids were playing around and we were interrupted many times. I had the feeling that she preferred this informal environment to a private discussion. I asked her to tell me the story of how she had decided to have a child/ren and build a family, and how she had decided to turn to ARTs to do it. She started by saying that she had forgotten everything and that it did not change anything. She felt like all other families, and the conception of her children had no impact on her family, she said. Once the normality of her situation had been asserted, she started to tell me her trajectory. Thirty years old when she met her current husband, she already had the feeling of being too old to have children, or behind the reproductive timing that she had in mind. The couple decided to turn to reproductive medicine after a few months of unsuccessful attempts and a miscarriage. In order to be sure that she would be taken seriously, she told the doctors that she had been trying for much longer. After undergoing the first examinations, she was told that she had a blocked tube, and that her husband had a lower quality of sperm according to current standards. In other words, nothing was insurmountable, conception was not impossible, but would maybe take more time than expected.

She explained to me how important it was for her to go fast, not to lose time, and how she opted for IVF as a means of going faster and catching up on the delay she felt she already had. Very confident in medical technology, she underwent an IVF and five embryos were conceived. Two were implanted and three frozen. She was pregnant after the first transfer with one child, and two years later with a second one. All the embryos were thawed, in total four were implanted, and

only two developed. She told me that she was very happy with the whole process. She had had two children within two years, exactly as she wanted. She then spent a lot of time explaining to me in detail her pregnancies, and births, and insisted on the hard time she had had after the birth of her first child and the difficulties entailed by becoming a mother. What struck me in this trajectory, is how IVF is seen as a way of going faster, and when it holds its promise and brings the desired child quickly, it allows reinscription in the dominant family model and normative life course. The "normality of motherhood" was especially reaffirmed through "mother talk" and the sharing of birth and mothering experiences. What caught my attention too, is how the perception of time changed through the process, in the sense that had I interviewed her during the treatment, she would probably have had a very different perception of time. Once the children were born, and her goal of building a family reached, IVF was above all described as an easy solution, as a way of controlling the procreation process, better than with spontaneous conception, and especially of controlling its timing better.

Louise[28]

I met the second woman, Louise, in her modern and spacious five-roomed apartment. She contacted me spontaneously after having seen my call for participants in the forum described above, including, of special interest for me, a line of discussion reserved for "ELD". This acronym designates the "Essayeuses de Longue Durée", which means the "long term tryers". This line of discussion responds to two other lines, simply called, "essayeuses" (tryers) and "impatientes d'être essayeuses" (impatient to be a tryer). On this online forum, time is already an issue, and especially the temporal dimension of the attempts to have children is used to categorize oneself under one or the other heading.

Living in a residential area and afraid that I would get lost on the way, she came to pick me up at the bus station. We started the discussion walking together to her place and she started to explain her trajectory to me. Married a few years ago, with the man "perfect for her", they started to try to have a baby on their honeymoon. Both young and perfectly healthy, she tells me that she expected that it would be very quick and suspected that something was wrong only after two or three cycles without becoming pregnant. They first performed a sperm examination, which revealed that her husband was azoospermic[29]. After undergoing three IVF-ICSI with the husband's sperm, they turned to donated sperm, which had the effect of displacing the problem, as her possibly low ovarian reserve then became a reason explaining the failures. What struck me

[28] This case is analysed in more depth in Chapter 6.
[29] Means that there is (almost) no sperm in the semen. Medical terms are explained in the glossary (Appendix 1).

is that in a situation where age had *a priori* nothing to do with it, because the couple was young from a reproductive point of view, and that infertility cause was clearly masculine, her age appeared nevertheless as an explanation for the repetitive failures of ARTs treatment.

Charlotte[30]

Whilst in Jasmine's case, age was not a problem from a medical point of view, but was one of the motivations to turn to IVF, in Louise's case, age emerged as a problem after several unsuccessful attempts and became a gendered explanation of the treatment failures. The third woman I met, Charlotte, added another dimension to my emerging interest for what I called temporarily "the question of age". She contacted me through the same online forum as Louise and I met her with her partner in their workplace's office. 39 years old at the time of the interview, Charlotte started the discussion by saying that she had "a little bit of a problem of the biological clock", especially in comparison with her partner who was eight years younger. Telling me their story, she explained that she started reproductive treatment five years previously after the gynaecologist discovered that she had blocked tubes. Her partner's sperm was not matching the standards, but the problem was supposed to be overcome by using ICSI[31]. After the removal of her two tubes, two IVF cycles were performed. The first was unsuccessful and she had a hyperstimulation with the second one. A great number of embryos were frozen in regard to the usual standards and transfer cycles have become part of her yearly routines.

In this third case, age is thematized because of the age difference between Charlotte and her partner, and because she gets closer to the forties which represents a symbolic barrier, after which she does not imagine herself – at the moment of the first interview – as becoming a mother. Age is apparently not the cause of infertility when the first IVF cycles are performed, but the repetition of unsuccessful attempts, corresponding to the passing of time, and advancing age, makes it a crucial factor in the decision the couple will have to take. Is it still worthwhile to try an IVF with one's own eggs? Should they turn to egg donation? Or just stop because she considers herself as too old to have a child? Here the age difference between the partners created a tension between their respective reproductive schedules. Too early for him, when she wanted first to have a child, and now that she considered stopping treatment, he felt he had reached the right moment and wanted to turn to other options.

[30] This case is analysed more deeply in Chapter 7.
[31] ICSI is an Intracytoplasmic Sperm Injection, which means that a sperm is directly microinjected into the oocyte. In contrast with standard IVF, only one sperm is necessary for the fertilization. See https://www.eugin.fr/traitement-fiv/icsi/ for a simple explanation of the procedure. See also the glossary (Appendix 1).

The way that age and time were thematized and understood in various ways in these three cases marks the emergence of my interest in the "question of age". I called it like this temporarily because it was a convenient way of referring to the various elements related to age, such as presented in these three cases: the passing of time, a good time to be a mother, treatment failures, age difference, competing schedules, the biological clock, possibilities opened up by ARTs. In the interviews, it was a convenient tool, leaving enough space for my interlocutors' own understanding of the question, and just precise enough to refer to a specific dimension of reproductive medicine that they understood immediately. The term "question" was convenient because it was neutral and assumed that things were in question and perhaps problematic for some people, under some circumstances, but also more basically that it could not be taken for granted. It could refer to age-related infertility or to reproductive aging, to chronological age in itself, or to the "biological clock", a "heterogeneous concept that carries a range of connotations, emerging in the 1970s to capture the interconnections and fissures between social and physiological domains regarding women's bodies and reproduction" (Friese, Becker and Nachtigall 2006: 1551). Referring to the "question of age" was a convenient tool as it allowed people to grasp both its singularity – people knew what I was referring to – and its multiplicity – as it is enacted differently in practice (Law 2004; Mol 2002). The openness of the question was convenient as I did not want to assume or define *a priori* what could be understood or connected to it, but rather wanted to explore the ramifications that age gave rise to in their different facets and multiplicities.

My first interest and observations based on these three cases led me to explore in more detail the personal experiences of age and time, when it was possible. At that time of the research process, I wondered what age meant for the people I met, how they understood the role of ARTs in regard to reproductive aging, and what was their opinion about possible age limits of motherhood. I observed that sometimes age was a topic they discussed, while at other times, it was not an issue, and only more specific questions brought it to the fore. After meeting a certain number of couples or women, I realized that age was an issue, not only when women were older, which was very often the case, but also when there were failures, when the treatment was long and often people were still undergoing treatment, or had renounced the plan to have a child. On the contrary, age was not – or much less – an issue when the couple was young, and male infertility the principal cause of turning to ARTs. Among the people I met, both groups had very different narratives. In the first one, where age was an issue, trajectories were long and full of obstacles and complications and IVF was associated with sufferings and pains. In the second one, people had children easily, IVF seemed to work successfully, and there was more to say about pregnancy,

birth, and motherhood, than on IVF itself. Of course, a closer look shows how it is more complicated than that, and even the successful narratives of IVF are revealing and worthwhile digging into, but the difference struck me and gave me the impression that there was more to understand in the complicated stories. Very basically, people had more to say about their experience of infertility and ARTs. At this point, I assumed that age in its many understandings worked as a magnifying lens of the experience of infertility and ARTs, allowing me to grasp the difficulties and the ambivalence of ARTs treatment, and more than that that it might be co-produced through the experience of turning to ARTs.

The sense that age was a key notion for understanding the experiences of infertility and ARTs was confirmed by my visitation of the online forum. Encouraged by my first impressions regarding the centrality of the question of age, I started to look more specifically for women facing age-related infertility and/or turning to egg donation. For this purpose, I posted a call for participants in the discussion line dedicated to mothers over 35. This call did not meet with any success, while the same message in the discussion dedicated to reproductive medicine, allowed me to meet a third of the participants in my study. More generally, I could observe that the discussion for mothers aged over 35 was very slow, it was rare to see new posts or discussion, whereas the one on reproductive medicine was very animated. The lack of success can have several reasons, but my hypothesis was that the association between age and ARTs that I was making was appealing to persons undergoing reproductive treatment who felt a recognition of their experience, while for mothers over 35 it could have been perceived as an offense, as an additional judgment, or as the possible suspicion that their pregnancies were not "natural", reinforcing the stigma associated with older pregnancies (Friese, Becker and Nachtigall 2008).

2.3.2. THE PROHIBITION OF EGG DONATION

In parallel to the first interviews with people undergoing reproductive treatment, I started to explore the regulatory and political context of ARTs in Switzerland. As the laws on ARTs vary much in Europe (Pennings 2009), they create specific conditions determining the access to and use of ARTs. They are very much studied for this reason (e.g. Engeli 2010; Pennings 2003; Rothmayr, Varone and Montpetit 2003; Varone, Rothmayr and Montpetit 2006) but also to understand what values, norms and models underlie them (e.g. Franklin 1999; Melhuus 2009; Rochebrochard and Rozée 2010; Salazar 2009). Switzerland is characterized by a restrictive regulation of ARTs compared to other European countries, similar to the German and Austrian regulations (Schmid 2009). The Swiss Reproductive Medicine Act (RMA 1998) which came into

force in 2001 is turned toward the protection of the well-being of the child and prohibits egg donation, unlike sperm donation which can be accessed by married couples for medical reasons[32]. I soon realized that this prohibition had much to do with age, even though not directly.

Egg donation and IVF using donated eggs refer to the procedure by which the dysfunctional oocytes of a woman are substituted with those of another, often younger, woman, leading possibly to a pregnancy. Used in a first phase by young women with ovarian dysfunction or premature ovarian failure, it has been increasingly used by older women in their forties and fifties as a way of overcoming age-related infertility (Sauer and Kavic 2006). As a consequence, its prohibition entails that older women have to go abroad to access the procedure. As in other countries, postmenopausal pregnancy cases are highly publicized and controversial, and presented as an example of reproductive medicine going too far (Campbell 2011).

If some of these elements are not specific to Switzerland, the prohibition of egg donation and the prospect of its possible authorization created a specific context where the question of age gained in importance and was discussed. This regulatory context led to my interest in the relationship between egg donation and age, and more especially in the anti-aging dimension of egg donation, in the sense that it enabled the extension of fertility in spite of reproductive aging. My interest focused in addition on the debates that the crossing of various boundaries – natural, national, intergenerational, ethical – gave rise to, and in the complicated relationship between age and ARTs.

In order to explore that relationship, I decided to meet clinicians working in the field of reproductive medicine, as well as other experts, such as legal experts, psychologists, and a public health officer in charge of reproductive medicine. When I started my research, egg donation and the "reproductive tourism" its prohibition gave rise to were an inflammatory topic. It was a kind of open secret about which some clinicians were reluctant to talk. However I could observe an increasing openness towards the topic and in February 2014 the Swiss Parliament agreed to examine the authorization of the procedure and to elaborate a draft bill[33]. Even though the process of legitimization and possible legalization of egg donation are not at the core of my analysis in itself, I found this period of change to be highly interesting for understanding the models, norms, values, and positioning at stake, in relation to the procedure.

[32] More detailed information on the Reproductive Medicine Act can be found in Appendix 2.
[33] See Appendix 2 about the current changes in the legal regulation.

If at the beginning of my fieldwork only egg donation and cross-border reproductive care (Shenfield et al. 2010) were discussed, increasingly the possibility of egg autocryopreservation, commonly called "social egg freezing" (e.g. Lockwood 2011) has also been debated. This is due to the placing on the market of a new biotechnology, vitrification. It consists of an ultra rapid cooling process where oocytes are put into extremely low temperature liquid nitrogen with high cryoprotectants doses whose viscosity prevents the formation of ice crystals (Blyth, Lee and Yee 2013; Cobo et al. 2013; Gook and Edgar 2007; Technology 2013). In other words "to vitrify is to transform a substance into "glass", to render it stable and inert through very rapid cooling to about -1000C, where molecular activity ceases" (Waldby 2014: 3). By making oocytes independent from time and place, vitrification might change the landscape of reproductive medicine, and especially of egg donation programs (Bühler 2014a; Cobo et al. 2010; Mertes et al. 2012; Waldby 2014).

The entry into play of this new cryopreservation possibility renewed the scientific and public interest in the "question of age" including debates on the age limits of motherhood, the so-called social or elective and medical uses of the procedure, older motherhood in general, and differences between men and women. This strengthened my interest in the question of age, and led me to enrich the data on the experiences of women and couples undergoing treatment with data on the broader context. The focus on egg donation drove my attention not only on meanings of age during reproductive treatment, but also to question the possibility of medically extending fertility, the production of age limits, and the way in which public discourses and debates articulated with intimate narratives and experiences.

2.3.3. GAP IN THE LITERATURE

Additionally, a first review of the literature lead me to observe that age was an underexplored topic in the social science literature on ARTs. Born from empirical observations, my interest in the question of age was confirmed by the identification of a lack of literature on the topic. While aging studies tend to focus on later life, thought of as non-reproductive, and give little attention to the transformations of a "new middle age" (Featherstone and Hepworth 1996 (1991); Hepworth and Featherstone 1982), studies on ARTs usually fail to take into account age and aging, although the postponement of childbirth is usually presented as one of the main reasons for their increased use. More specifically, in the science and gender studies literature egg donation is celebrated as "one of the foremost feminist issue of our time" (Konrad 2005: 11), that could theoretically enable "women of any age to become pregnant" (Konrad 2005: 11), "break[ing]

down some of the more oppressive aspects for women of the "biological clock" " (Thompson 2005: 174) and contributing to destabilizing the distinction between ageless men with unlimited fertility and infertile aging women (Löwy 2006; Löwy 2009). It also opens up the possibility of reversing generational ascent, whereby a daughter gives eggs to her mother, as in the case study analysed by Thompson (2005), or to skip a generation (Edwards 2009). It raises then the risk of "anachronism" – "mistake in a normative systemization of time" (Russo 1999: 21) – subverting the order associated with intergenerational relations. From a feminist perspective, egg donation is thus recognized as an unprecedented way of addressing the "biological clock" problem and of subverting the categories of a normative lifespan, but the conditions of possibility of these transformations, as well as the impact of the medically assisted extension of fertility time on understandings and definitions of reproductive aging remain understudied.

Studies on egg donation tend to focus on the financial and moral economies of egg donation especially in the framework of transnational reproduction and biomarkets, where the demand for eggs is increasing to meet the demands of childless couples and of stem cell research (e.g. Almeling 2006; Almeling 2007; Bergmann 2011a; Bergmann 2011b; Curtis 2010; Hobbs 2007; Pollock 2003; Spar 2007; Waldby 2008). Another important area of research is about the making of kinship and the perceived fragmentation of motherhood (e.g. Bestard and Orobitg 2009; Franklin and McKinnon 2001; Kirkman 2003; Kirkman 2008; Konrad 2005; Lessor 1993; Melhuus 2009; Orobitg and Salazar 2005; Spilker and Lie 2007; Thompson 2005). In all these studies, aging is an implicit topic whose study could be deepened. In contrast, studies on late pregnancies and late parenthood tend to underevaluate the importance of ARTs on the life trajectories of older parents (e.g. Bessin and Levilain 2012; Dillaway 2006; Moguérou et al. 2011; Shelton and Johnson 2006; Windridge and Berryman 1999).

This situation has changed during my project, due to the possibility of cryopreserving one's own oocytes and thus of extending female fertility. As with any new biotechnology, vitrification sparked many medical, ethical, and social debates. Whilst oocyte cryopreservation in cases of cancer has never given rise to much public questioning, the increased use of vitrification in anticipation of gamete exhaustion, also called self-donation of oocytes (Rybak and Lieman 2009), by healthy women has attracted much public attention and critics, and has renewed interest in the question of age. Themes studied in relation to "social egg freezing" focus mainly on reproductive rights and choices, on the biomedicalization of women's bodies, and on issues related to the reconciliation of work and family and to a re-evaluation of the reasons leading women to postpone childbirth (e.g. Almeling, Radin and Richardson 2014; Daly and Bewley 2013;

Lockwood 2011; Sobotka 2013; Wunder 2013). Whilst the risk of increasing pressure on women to anticipate their reproductive futures (Martin 2010), as well as the illusory technological fix it promises to be, are criticized, the empowering dimension of egg freezing as enabling women to synchronize conflicting timescales (Waldby 2014) is also stressed (Belaisch-Allart et al. 2013a; Belaisch-Allart et al. 2013b; Goold and Savulescu 2009; Mertes and Pennings 2011; Rybak and Lieman 2009).

This new area of studies put to the fore the relationship between ARTs and the impact of medically assisting female fertility on women's lives. However, what remains understudied up to now is reproductive aging itself. What is reproductive aging in the first place? How do ARTs contribute to its production? How may the possibility of extending fertility transform its definition and understanding? While strengthening the interest of my focus on the question of age, this literature also oriented me in focusing on these elements that are upstream of the transformations of the reproductive schedules. As it was only at the end of my fieldwork that this possibility became available in some centres in Switzerland and I did not meet any woman turning to the procedure, I did not focus on social egg freezing itself. However, as it was much present in the public debates on the question of age I integrated these elements into my questioning about the biopolitics of the medically assisted extension of fertility (see chapters 9 and 10).

2.3.4. THE SCIENCE OF REPRODUCTIVE AGING

All the above-mentioned elements encouraged me to tighten my questioning on the central category of reproductive aging or of age-related infertility in its relation to ARTs. This interest and focus on the biology of the end of fertility was decisively confirmed when I discovered scientific studies on the possibility of producing "unlimited eggs" (Hastings 2012). Exploring the relationship between ARTs and age for about six months, these titles questioned me. The fertility decline that seemed so taken for granted in clinicians' discourse and that mattered so much in the narratives and experiences of women undergoing ARTs, seemed actually not so well-founded in the science of reproductive aging. Starting from these newspapers, I researched the work of the scientists who were at the source of this "discovery" and realized that it was controversial in the field of reproductive biology itself.

The gap between the idea that eggs could be regenerated and the ovarian reserve renewed, and the idea that eggs were inexorably decreasing in quantity and quality, was productive for me. How

could such different understandings of reproductive aging be produced in different sites? This confirmed my interest in the potential of ARTs not only to extend the female fertility span, but especially to transform meanings of reproductive aging. It also helped me to formulate the two axis of research at the core of my work. On the one hand, I wanted to understand how age mattered so much in reproductive medicine and in the experiences and narratives of people undergoing treatment, and how on the other hand, ARTs contributed to extending fertility and to transforming meanings of reproductive aging. This tension between age as a limit of fertility and ageless fertility is productive in the sense that it constantly recalls that age – its ontological status and its biopolitics – is under question, and that this fundamental uncertainty is constitutive of its circulation and multiple enactments.

2.4. Following age…

When I started this research, the lack of a bounded site in which to perform participant observation worried me. As an anthropologist afraid of losing the depth of ethnography, it was challenging to distance myself from the reassuring thought of a fieldwork bounded in space or of a multi-sited fieldwork that would take place in different well-defined places. Even though the idea of fieldwork as a mythical rite of passage has been criticized (Olivesi 2005), I was much imbued with this myth and believed (and still believe) in the strength of ethnography. Challenging this idea pushed me to redefine the object of my research and think about it differently. Instead of trying to give an account of a reality out-there, I accepted that I was actively not only describing, but also producing this reality, and that I had to create a "method assemblage", uncertain and diverse, in order to account for the multiplicity, the indefiniteness, and the flux that I was encountering (Law 2004). A key moment is when I stopped thinking about fieldwork as something that was pre-existing my presence, and rather as something that I was actively constructing. Instead of a reassuring bounded space, following age in several settings helped me to draw out its multiple ramifications, with a fieldwork looking more like a "rhizome" (Deleuze and Guattari 1980b; Zourabichvili 2003) with expanding and multiplying ramifications. A rhizome is characterized by the philosophers, Deleuze and Guattari as such:

> *Let us summarize the principal characteristics of a rhizome: unlike trees or their roots, the rhizome connects any point to any other point, and its traits are not necessarily linked to traits of the same nature; it brings into play very different regimes of signs, and even nonsign states. The rhizome is reducible neither to the One nor the multiple. […] It is composed not of units but of dimensions, or rather directions in*

motion. It has neither beginning nor end, but always a middle (milieu) from which it grows and which it overspills (Deleuze and Guattari 1987: 21).[34] .

The notion of rhizome reflects very well the reconceptualization of a site I needed to think about as my fieldwork, but entails a repositioning of the subject/object distinction and also raises additional questions such as where to situate oneself? Where to start and where to end in a complex of multiple ramifications without ending and beginning? Where to go when so many different directions open? The notion of "following" developed by Marcus in his famous article on multi-sited ethnography (Marcus 1995), as well as in actor-network theory (Latour 1997) was very helpful for redefining my object, not in the sense of a place where I would study some practices, but in the sense of an object – age in relation to fertility and ARTs – which I was following along different lines and along different directions, and that was constantly redefined. The notion of following implies the "capacity to make connections through translations and tracings among distinctive discourses from site to site" (Schlecker and Hirsch 2001: 72, referring to Marcus 1995) with the challenge of finding out "where interesting things might be going on" (Hine 2007: 661) and raising the important question of adequacy between the argument and the empirical data (Hine 2007).

However it was difficult to get rid of the notion of a defined space, and the definition of a site remained problematic for me. Could scientific articles be a site? Could people's homes be a site? Or was Switzerland the site where my research was taking place? At stake were questions of scale, of people, of objects, of space and time. In his chapter on ethnography and STS, Hess lists the "points of exposure and triangulations" increasingly constituting fieldwork: "attending conference[s], working in laboratories and schools, attending virtual chat rooms and real-world colloquia, interviewing a wide range of persons associated with the community, reading a vast technical literature, working in archives, developing long-term relationships with informants (who may, over time, become friends or even co-researchers), interviewing outsiders and laypeople about their perception of the expert community and its products, becoming a part of activist and social movement organizations, and providing services and to the community" (Hess 2001: 239). This diversity is compensated according to him by the duration of the fieldwork that should be up to ten years. While I have not studied age and ARTs for ten years, it was helpful to identify

[34] Original quote: "A la différence des arbres ou de leurs racines, le rhizome connecte un point quelconque avec un autre point quelconque, et chacun de ses traits ne renvoie pas nécessairement à des traits de même nature, il met en jeu des régimes de signes très différents et même des états de non-signes. Le rhizome ne se laisse ramener ni à l'Un ni au multiple. […] Il n'est pas fait d'unités, mais de dimensions, ou plutôt de directions mouvantes. Il n'a pas de commencement ni de fin, mais toujours un milieu par lequel il pousse et déborde" (Deleuze and Guattari 1980a: 31).

these "points of exposure and triangulation" that could work as "focale" or "points of sustained attention" in a network (Beaulieu, Scharnhorst and Wouters 2007).

Keeping track of this journey through notes was crucial and I wrote down some words, thoughts, and descriptions, after each meeting and observation, as a means of not getting lost and of being able to retrace my steps. Situational maps "that lay out the major human, nonhuman, discursive and other elements in the research situation of concern and provoke analyses of relations among them" and "intended to capture and discuss the messy complexities of the situation in their dense relations and permutations" (Clarke and Friese 2007: 370) proved also to be useful tools. They helped me to take stock of the situation of my work and to situate myself among the many ramifications that I was following.

Through following age, three nexuses emerged as more dense, complex and more visible also. These three nexuses constitute the three flows which I decided to follow in more detail and that ended up in the three parts of my dissertation. The first one is the science of reproductive aging, the second one comprises the narratives and experiences of people turning to ARTs, and the last one covers the biopolitics of age-related infertility in Switzerland and associated medical experts' accounts.

The crucial problem was then how to stop, as it was always possible to go further and to follow a new ramification, or in Strathern's words, "where to cut the network" (Strathern 1996). Grounded theory has proposed the notion of "saturation" to describe the sensitive moment where after much cross-checking and back-and-forth between empirical data and emerging conceptual categories, the researcher reaches a point where he/she is not able to find data adding to the previous dimensions identified (Glaser and Strauss 2009; Quivy 2006). This was a good tool helping me to stay still and to explore the ramifications surrounding me from a momentarily fixed point. However, I am conscious that for each of them I could have gone further, that many other paths and other ramifications could have been followed. The account of my journey made in this dissertation is thus the result of the several nexuses I stopped in, and thus not in any case a definite ending. On the contrary, it opens new questions, indicates new ramifications to follow, and is therefore to be considered as a "fluid result" or a partial conclusion (Law 2004).

2.4.1. … IN ITS SCIENTIFIC TRACES

The exploration of the first nexus required that I develop specific understanding of biological and demographic concepts and that I make my way in a place made of paper, digitalized data, words,

schemas, and pictures of several kinds. The motors of research PubMed, Web of Science, and Google Scholar became tools most helpful in digging into this nexus in a systematic way with the help of key words. Following the sources and going from one source to the other also became a crucial strategy that allowed me to reconstitute some ramifications of the history of reproductive aging. Going back into this history proved necessary in order to understand the constitution of the category of reproductive aging, which results from the traffic between the reproductive and anti-aging or regenerative sociotechnical projects (Squier 2004), as well as the infrastructural elements and conditions of possibility underlying it. Progressively cross-checking the sources helped me to map the broader picture even though only some parts and connections are highlighted here.

In contrast with lab studies, scientific articles are a final product, a kind of momentarily stabilized version of their object of study far from the material and practical making of science that has been put in the forefront by STS studies. This raises specific methodological problems. How to deal with this kind of texts? How to deal with their unsituatedness? Their decontextualized character? This kind of virtual space of discussion and of production of knowledge? In other words, how to make the articles speak? To make them speak I had to find good questions, which were: What is reproductive aging? How are age and fertility connected? And what is the role of ARTs in the production of knowledge about it? To get answers, the methods sections have been most useful. Drawing on Landecker (2007), methods sections allowed me to gain an insight into the practices and the technical and material aspect of producing knowledge (see also Mol 2002 who discusses the problem of getting access to practices in scientific articles). They are indeed an integral part of scientific articles and constitute a unique way of understanding how scientists proceeded to collect and analyse their data, especially for articles of the past where there is no other way of access.

Review articles were very useful too. They are not based themselves on empirical work, but rather present the current state of knowledge about a specific topic. They point to the open questions, points of debates, to lines of research that should be explored further, and propose new directions usually in relation to the research of the authors. Thus they enabled me to map out research done at one moment of time in relation to a certain subject and to identify what parts of knowledge are considered as stable, and what are not. In addition, they enabled me to have a synthetic view of the questions and ways of answering them, practically and epistemologically, developed at a specific moment. Finally, the introductions, conclusions, and position articles have

also been very useful as places where scientists reflect on their work and situate it in regard to broader social and medical issues.

While going back into the history of reproductive aging has lead me to the end of the 19th century, my analysis draws mainly on data published after the second world war as that marks the premise of what will become the demographic and medical concern for the question of age, and especially on data published after the birth of the first test-tube baby in 1978, as it marks the moment where IVF enters successfully into play by opening up the prospect of changing the game in this regard. As new research is constantly published, I stopped the collection of articles in 2013. Among the corpus of articles collected, I tried to identify milestones marking out key moments in the history of reproductive aging through systematically crosschecking sources. Then I studied more deeply some articles I found relevant in regard with the broader picture as highlighting crucial aspect of the role of ARTs in relation with reproductive aging.

2.4.2. … IN THE NARRATIVES OF PEOPLE UNDERGOING ARTS

The second nexus I explored is made by the narratives of people undergoing ARTs, their experiences, decisions, tears, hopes, needs, love to give, disappointments, and fears. Through them I entered the world of reproductive medicine, its strict schedules, its norms, its exams, and its promises. Through them I started to understand how age matters in the clinic in multiple and sometimes contradicting ways. I was able also to gain an insight into the way the promise of medically assisting the extension of fertility was potentially transforming understandings of reproductive aging. I did not follow people themselves, for example when they travelled to Spain to seek treatment, which could have been an option, but I followed the question of age and its transformations, as it appeared in their narratives and experiences.

After coming into contact with them as described above, I let people decide where they wanted to meet and if they wanted to meet me alone or as a couple. At the beginning, the goal was to explore their personal experiences and narratives of infertility, family, reproductive medicine, and when relevant pregnancy and life with children/a child. As the focus on age became more important, this aspect became centrally explored. I met most people in their homes and some of them in cafes. Usually email exchange and sometimes a phone call preceded the first meeting. These exchanges were important in the sense that our discussions were already starting spontaneously during these informal moments. Using public transport for my travel, I spent many hours in trains or buses taking me all over the French part of Switzerland. Often people

came to pick me up at the train or bus station, which provided us with the opportunity of starting informal discussions, situating each other, and creating a connection. I used always to bring some biscuits, chocolates, or small treats. They often offered me something to drink, coffee, tea, water. Sometimes we shared meals. Sometimes children or other extended family members were around, sometimes we were alone. Discussion could last an hour, but also up to four hours, for example when an evening was spent together. They usually brought me back to the station, which gave us an opportunity to continue the discussion. Then we usually stayed in contact through emails. Sometimes I had additional questions, for example details about a date of birth, or number of IVFs undergone, that in the moment of the discussion had not emerged clearly. Sometimes I had more questions on the content. I always left open the possibility of meeting them again, and most of the time they were ready for it. This was especially important with the people undergoing egg donation, who were more difficult to find, because it allowed me to see them several times, before treatment, during pregnancy, and after the birth. I stayed in touch with several women or couples, seeing them also more informally. While not situated in one single place, and without knowing each other, these people nevertheless formed a kind of community based on similar experiences of infertility and of turning to ARTs to have a child, in a way similar to the "imagined community" characterized by Salazar and Orobitg (2012).

The interviews strictly speaking were recorded, anonymized, and transcribed[35]. I started by asking the couples or the women what had lead them to desire a child and to decide to build a family and how they had turn to ARTs to do so. I had prepared follow-up questions in relation to the themes I wanted to discuss with them. The final question was about the ethical dimension of ARTs and about what according to their opinion should be allowed or prohibited, encouraged or not, and why. I usually presented examples taken from the media to make the question more concrete. It was interesting because it helped to create a distance at the end of the interview to decentre their own experience and reflect on norms, values and models (about the use of the press in interviews, see Salazar and Orobitg 2012). The narrative format of our discussions allowed them to start where they wanted and gave them the opportunity to tell me their story in a way that made sense for them.

During the interviews, I was sometimes shown pictures, of embryos, babies, and members of the family. Sometimes my presence had an impact on the decision to speak to the children about their conception. Sometimes they asked me questions about my own situation and experiences. Sometimes it was more like a formal interview, and sometimes more like a discussion between

[35] My profound gratitude goes to Nathalie Morel who transcribed the interviews in such a professional way.

almost friends. I usually tried to reformulate their words to be sure that I had understood correctly, which sometimes was not the case, and lead to other reformulations until we found the good formulation expressing what they wanted. During these discussions, meanings were co-produced through my exploration of "the meanings they place on events in their world" (Sherman Heyl 2001: 369). The "emotional labor" (Carroll 2013) that I performed during these meetings as I had to deal with the anxieties, sadness, disappointment, frustration, but also hopes, and desires, generated by the experience of turning to ARTs, and making me sometimes look more like a confident or a therapist of some kind than a researcher, was intense and demanding, but also very productive in the sense that it is through this "incorporation of emotions" (Carroll 2013) that knowledge was co-produced.

While not directly properly part of the research, I learned much just speaking to friends in an informal manner. Many friends or acquaintance, mostly women, had an opinion, or something to say about IVF. They had heard of, or knew somebody undergoing ARTs treatment. I had also a few friends who found themselves facing infertility and/or turning to ARTs. Sometimes informal discussion with them helped me to understand crucial aspects of the experiences of people and helped me also to grasp how my own discourse and thinking were changing as I was meeting more people, and deepening my understanding of the field. Benefiting from a training and professional previous experience as a nurse, I also administered the injections to two close friends for several cycles (IVF here first and then egg donation abroad). While my analysis does not directly draw on these cases, it informed my way of thinking about my theme of research by giving me close insight into what the personal experience of age-related infertility and turning to ARTs might be.

While I do not do justice to the richness of all these encounters and to the many stories I had the privilege of being told, I keep from all these moments the sense of a long journey into the intricacies of ARTs, age, infertility, and much more. In Sherman Heyl's words, I can consider myself as a traveller "on a journey from which to return with stories to tell, having engaged in conversation with those encountered along the way" (Sherman Heyl 2001: 371).

2.4.3. … IN THE ACCOUNTS OF MEDICAL EXPERTS

The third nexus I explored is constituted by the accounts of medical experts in relation to the broader biopolitics of reproductive aging and ARTs in Switzerland. When I decided to focus on the "age question" it became clear to me that I could not only focus on the patients' narratives.

They were so much intermingled with biomedical understandings of reproductive aging that I decided to follow age in the medical and clinical accounts. I contacted physicians, clinicians and biologists working in the field of reproductive medicine, through their websites first, and then following the snowball recruitment method (Atkinson and Flint 2001). Meeting doctors was very different from meeting women or couples undergoing reproductive treatment. While the latter were saturated with personal feelings, doubts, questions and intimate decisions, the discussions with doctors were always placed on the level of an expert speaking to a layperson, sometimes taken for a journalist. I met medical experts in their offices or at the clinic, and often they did not have much time to answer my questions. Sometimes we were interrupted by a phone call, and once a doctor even had to leave to attend a birth. The way I met them can be very adequately described by the way Beaulieu characterizes co-presence, that "involves not so much the ability to travel, but rather emphasizes coordination, flexibility, availability" (Beaulieu 2010: 459), to the point that "sometimes when the field would be available is more important than where it could be found" (Beaulieu 2010: 459).

My questions were focused on age, how it was assessed, what was its impact on fertility, how the doctors defined reproductive aging, how it was related to egg donation, what was their position regarding the prohibition of egg donation, and cross-border reproductive care, also what was their understanding of post-menopausal pregnancy cases, and of future possibilities such as egg cryopreservation.

As psychologists, or counsellors, are an integral part of the reproductive medicine clinic, I also met several of them, as well as an alternative therapist with a long experience with patients suffering from infertility. I could observe an institutional distinction in the distribution of tasks, between the physicians who took care of the medical aspects of infertility, and the psychologists, who were in charge of supporting couples, of understanding their experiences, exploring their meanings, sometimes also assessing their eligibility. In a complementary way, these discussions allowed me to understand what age was from a clinical perspective, and specifically how age was at the core of medical practices in a way where its transformations would have an impact on the medical body itself.

To grasp the public and biopolitical dimensions of these medical discourses, I followed age at different kinds of public events organized in the field of reproductive medicine, involving professional and/or patient audiences. I attended conferences, information sessions for patients, a scientific café, and workshops. My attention was always floating, attentive and ready to seize

anything – from media articles, to some discussions on the Internet, including some movies and theatre play – related to my subject. Of course, all this data cannot be analysed in detail and I had to make choices that do not do justice to their richness, but it was a way of being immersed as much as I could in the world of ARTs and infertility and to grasp the many ways in which age appeared. This different framing of the question of age was also put into perspective with what I could read in the media. What is interesting is how the notion of scale and of what is local or global was complicated as some scientific discovery made in the US or the UK, was then read and discussed by Swiss people, and as people turned to digital and material resources – informational, medical, and reproductive – abroad in a way that highlighted both the specificity of the Swiss context and that loosened its importance.

As medical practices are strictly regulated by law, I needed to take into account the Reproductive Medicine Act (RMA 1998) that came into force in 2001. It was a crucial site in order to understand how the age of reproduction is legally and clinically regulated, but also how possible legal changes might reopen the question of the "limits" of age determining motherhood. In order to understand the stakes of the possible authorization of egg donation, I also met a legal expert and a bioethicist to obtain their expert point of view on the prohibition of egg donation, possible authorization, and age limits. To complement this, I collected various documents, such as parliamentary motions, or official paper positions on the subject, in order to keep track of the medical positioning in the debates regarding the legal regulation of ARTs.

2.5. Partial positions

> *A commitment to mobile positioning and to passionate detachment is dependent on the impossibility of innocent "identity" politics and epistemologies as strategies for seeing from the standpoints of the subjugated in order to see well. One cannot "be" either a cell or molecule – or a woman, colonized person, labourer, and so on – if one intends to see and see from these positions critically. "Being" is much more problematic and contingent. Also, one cannot relocate in any possible vantage point without being accountable for that movement. Vision is always a question of the power to see – and perhaps of the violence implicit in our visualizing practices (Haraway 1991a: 192).*

> *We are a set of partial connections. We are, to use the language that I am proposing, both in-there, as subjects, and out-there, as networks of meaningful and material relations. […] And objectivity, in the way Haraway redefines it, is possible if we acknowledge and take responsibility both for our necessary*

> *situatedness, and for the recognition that we are located in and produced by sets of partial connections (Law 2004: 68-69).*

Much has been written on the ethics and politics of ethnography. In this final section I simply want to highlight some of the ethical and political stakes raised by my research. I think that reflections on this dimension of ethnographic work goes along with the research process and are not located in one specific moment. In other words, I do not think that the ethics and politics of my research can be solved by my obtaining the agreement of the ethical commission to do research or by my obtaining signatures on informed consent forms, even though that is part of it. I think that it goes beyond it and touches all the steps of the research process, from access, to the collection and analysis of the data, and feedback about the results (GRED 2008). The ethics and politics of research have been shown to be important for any subject and are already well problematized (e.g. Boden, Epstein and Latimer 2009; Cefaï 2009a; Cefaï 2009b; Fassin 2008; Fassin 2000). Here I want to focus on aspects related to age and to my positioning in regard to this question.

Knowing whether I had a hidden feminist agenda and if yes, of what kind, was often an implicit issue in the discussions with patients and doctors. More specifically, knowing whether I was in favour of the medical extension of fertility or not was somehow always present in the discussions as I pushed my interlocutors to position themselves while keeping my own positioning ambiguous and open. In fact I resisted taking a position because I wanted to understand how different versions of age-related infertility were enacted and had the feeling that thinking about it in bad versus good terms was limiting. I also wanted to complicate the narrative about the question of age, which is often approached in a stereotypical way in the media. I wanted to question the nature of age/aging before thinking about whether it was good or bad for women to have a new reproduction option, and especially because reading feminist accounts of reproductive technologies had taught me that ambivalence was at the core of the medicalization of reproduction in its many forms (e.g. Franklin 2013a; Franklin 2013b; McKinnon 2015). Women could both be objectified by biotechnologies, but also use them in an empowering way, and even though contradictory, these two dimensions often went together (Cussins 1996).

By resisting taking a position, I took a position anyway, because being situated is impossible to avoid. Just making reproductive aging the subject of my dissertation is probably situating it as a question of heterosexual, white, privileged women, as "the biological clock came to be stereotypically identified with a cohort of largely Caucasian, educated, upper-middle class, baby-

boom women" (Friese, Becker and Nachtigall 2006: 1551). However, I met women working in a factory and saving money to undergo IVF, as it is not reimbursed by medical insurance, and did not meet any woman who really fitted the figure of the careerist woman portrayed in the media. But it is true that most were white, most were in a heterosexual couple or relationship, and most had the financial means of undergoing IVF in Switzerland, and sometimes also the resources to go abroad for egg donation.

A reading that can be made from ARTs opening up the possibility of medically assisting fertility is that it is part of a "stratified reproduction" (Colen 1995; Ginsburg and Rapp 1995) strategy encouraging the more desirable – richer, more educated, whiter – citizens to reproduce. While this intersectional approach has nourished my reflections and the questions it raises are of the greatest importance, this dissertation is not an account about whether extending female fertility reinforces class, gender, and racial inequalities. It is not an account either, about whether the medically assisted extension of female fertility is empowering or liberating, or rather objectifying and alienating women.

Following feminist scholars in STS such as Franklin and Lock (2001); Mol (2002); or Thompson (2005), my position is instead to draw attention to the category of age itself, and to show that it is less stable, more complicated, more complex, more multiple than what is usually assumed. I also want to show that the role of ARTs is crucial in the production of knowledge about reproductive aging, and its various transformations, and thus that it goes beyond the question of the medicalization of women's bodies and lives, even though these aspects are very important. Instead of examining how ARTs might contribute to a greater equality between men and women, I am interested in showing how reproductive aging is gendered upstream at the incipient level of the emergence and construction of the category. As reproductive aging is a feature determining essentially women, I want to show that this category is complex, and that biology is not the stable ground it is thought to be. Furthermore, I am interested in how patients, scientists and doctors comprehend this instability, resist it, or on the contrary, endorse it actively.

Age was also a question of position in the many discussions I had with women. Did I have children? How old was I actually? Somehow, the interviews worked as a mirror of one woman facing another. As I already had two children when I started research, but was of an age when socially it is acceptable not to have any yet, these questions were underlying the exchanges and sometimes were made explicit. Sometimes by their questions women pushed me to disclose information about myself. Sometimes I was very happy to share with them and it created a

common ground of our experiences to relate to in the discussions. What was exactly shared? Maybe, it was the desire for a child that I had had, and could understand. Maybe also it was the profound ambivalence, which is at the core of motherhood for me and that I could feel deeply. It happened sometimes that I regretted that I had disclosed this information, as I could feel that it created an additional barrier in the relationship, as I had the children which women were struggling to have so badly themselves.

My ethics and politics were to stick to the greater authenticity. I did not hide my status as a mother during the interviews, and I thought of it as a way of understanding how age and fertility were related. According to the principles of ethnographic interviewing (Sherman Heyl 2001) and assuming that "emotion is a source of understanding, analysis and creativity" (Carroll 2013: 551). I also always tried to be as empowering as I could be, to be most respectful and understanding as possible, with the idea that our discussion touching such an intimate subject as the painful unfulfilled desire for a child, was not only a way for me to understand what was at stake, but also a way of recognizing and validating these women and couples in their experiences of turning to ARTs.

The will to understand deeply these experiences also makes it difficult for me to speak about the medically assisted extension of fertility in normative terms, or as something reinforcing gender, racial, and class, inequalities from a feminist point of view. By entering the intimacy of these experiences and as I felt so much sympathy and respect for the people I met, the focus was displaced from the broader structural picture to the many complexities and multiple positionings encountered in these experiences. I felt close to patients especially, but also to the medical experts whom I met, who helped me to understand the many challenges and ethical questions related to age-related infertility and its possible overcoming by egg donation and freezing. Somehow, sharing these experiences and questions with them enabled me to adopt a position consisting in standing on their side and trying to highlight as best as possible the complexities and intricacies of their positioning, questioning, and experiences. This dissertation is the result of this attempt.

Part I

From age to aging

The science of reproductive aging and its frontiers

3. The statistics of age and fertility

I am sitting in the comfortable patients' waiting room of Doctor A.'s well-appointed medical office, bathed in the light of late afternoon. I have just finished the coffee that his secretary offered to me, when he invites me to move to his consultation room. Once installed at his desk, he starts the discussion with these words: "So you know that natural fertility dramatically decreases. You see that if we take women at age 45 and over, you can see that the probability, out of 1000 women 25 have a chance of being pregnant after one year, and when they are pregnant, they have a 95% chance of having a miscarriage. Thus this is Nature. […] A small injustice between men and women" (Dr. A. 5.12.11). Accompanying his talk, he shows me a graph (Heffner 2004, see picture below) where two curves intersect in opposite ways. The first curve refers to the fertility rate per 1000 married women, while the second one refers to the spontaneous abortion rate. Both curves are correlated to maternal age and intersect around age 40, providing me with visual and statistical evidence that fertility does decline with age.

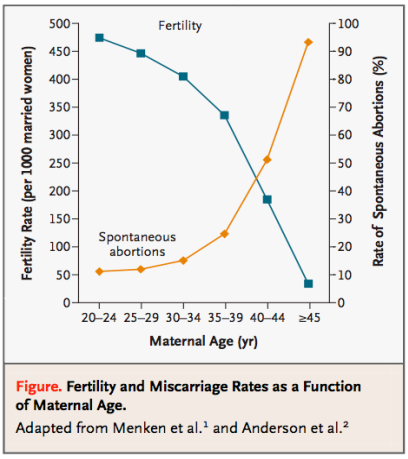


Figure. Fertility and Miscarriage Rates as a Function of Maternal Age.
Adapted from Menken et al.[1] and Anderson et al.[2]

(Source: Heffner 2004)

What first caught my attention in this moment was that I had already seen these statistics. Not only in the article referred to by Doctor A., but also at conferences dedicated to reproductive medicine professionals or to a broader audience, where this graph was displayed to show that fertility declines. Indeed, similar statistics and curves are regularly mobilized in newspapers and on the Internet. They are part of the public discourse on ARTs, fertility and the postponement of childbirth. Often debated, they are by turns accused of creating a false sense of alarm (e.g. Grose 2013), or in contrast used to assert the reality of the fertility decline and to warn women that they should take them seriously (e.g. Grigoriadis 2013). Their apparently easy circulation and

mobilization is contrasted by the common accusation that statistics can be easily manipulated and can say whatever one wants them to say, or in other words that they may easily lie (Desrosières 1993).

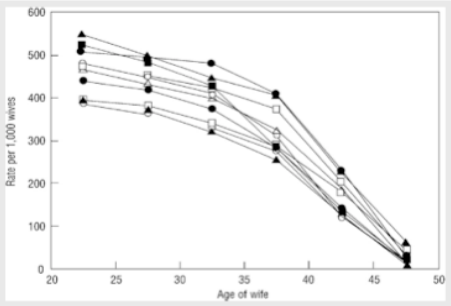
Besides this initial observation, another element struck me when, later, I thought back to this interaction. I could observe a slippage from the notion of "natural fertility", which is a demographic and medical concept, to the notion of Nature as the order of life and gender relations. The notion of "natural fertility", which has a specific historical meaning, was used here in the same sense as Nature, this universal and immutable order characterizing Western thought since the 17th century (Descola and Pálsson 1996; Hastrup 2013; Latour 1997). Indeed, by explaining to me what the natural fertility decline is, this expert had enacted two of its crucial aspects, namely its naturalized and gendered dimensions. However at the same time that the ontological nature of the fertility decline was asserted as pertaining to a taken-for-granted knowledge which we were supposed to share, what was actually shown to me was a graph with differently coloured statistical curves where maternal age was a central variable and where reference was made to other articles referred to as "Menken et al. and Anderson et al." (Heffner 2004). The gesture of displaying the graph worked there as the evidence of scientific truth and objectivity (Daston and Galison 2010), asserting a reality by erasing visually and verbally the devices used to produce the statistics of the "natural fertility" decline.

Interestingly, many recent scientific articles start with a reference to the decrease in fertility observed in historical or non-contraceptive populations, by referring, like Heffner (2004), to the article published by Menken, Trussel and Larsen on age and fertility, in the Journal *Science,* in 1986 (Menken, Trussell and Larsen 1986). As an example, the most recent Committee Opinion (n° 589) of the American College of Obstetricians and Gynecologists (ACOG) and of the American Society for Reproductive Medicine (ASRM), two bodies of experts making authority in the field of reproductive medicine, refers to them (ACOG and ASRM Committees 2014). The first figure (see below) presented in this article displays curves based on the marital fertility rates by 5-year age groups in ten different populations[36] characterized by their "non-contraceptive" status. In the body of the text, the comment explains that "age **alone**[37] has an effect on fertility" (ACOG and ASRM Committees 2014: 633), as demonstrated by the statistics based on historical data of populations that do not use contraception, showing that fertility rates decrease as women's age

[36] Hutterites, marriages in 1921–1930; Geneva bourgeoisie, husbands born 1600–1649; Canada, marriages in 1700–1730; Normandy marriages in 1760–1790; Hutterites, marriages before 1921; Tunis, marriages of Europeans 1840–1859; Normandy, marriages in 1674–1742; Norway, marriages in 1874–1876; Iran, village marriages in 1940–1950; Geneva bourgeoisie, husbands born before 1600.
[37] Emphasis added.

increases. The ways in which these statistics circulate in many articles as a self-evident reference gives them the status of a stabilized object of truth with a strong sense of universality, even more marked in the last example when data from ten different countries are compared in an ahistorical and decontextualized way.

FIGURE 1



Marital fertility rates by 5-year age groups. The ten populations (in descending order at age 20–24 years) are Hutterites, marriages in 1921–1930 (▲); Geneva bourgeoisie, husbands born 1600–1649 (■); Canada, marriages in 1700–1730 (●); Normandy marriages in 1760–1790 (○); Hutterites, marriages before 1921 (□); Tunis, marriages of Europeans 1840–1859 (△); Normandy, marriages in 1674–1742 (●); Norway, marriages in 1874–1876 (□); Iran, village marriages in 1940–1950 (▲); Geneva bourgeoisie, husbands born before 1600 (○). From Menken J, Trussell J, Larsen U. Age and fertility. Science 1986;233:1389–94. Reprinted with permission from AAAS.

Practice Committee. Committee Opinion No. 589. Fertil Steril 2014.

(Source: ACOG and ASRM Committees 2014)

However, their mobilization to assert and reassert the reality of the fertility decline, leaving it unquestioned, draws attention also to the object itself: very often a graph with curves or just figures associated with percentages referring to different kinds of historical populations or to natural fertility. But what is "natural fertility"? Where does this notion come from and why is it important to the statistics of the age-related fertility decline? At a more general level, how is the statistical evidence of the fertility decline constructed and how are "age alone" and fertility put in relation with each other? To address these questions, I focus on processes through which the evidence of age-related infertility is constructed in demographics and epidemiology, fields in which the notion of fertility is crucial for understanding the trends in population dynamics and the effect which social changes such as the postponement of childbirth may have on fertility rates.

The goal of this chapter is not to show how the age-related fertility decline is socially constructed in order to highlight that it could have been otherwise (Hacking 2008), or to point at some biases in the production of knowledge with the idea of showing that a better science could be done. Neither is the goal to highlight the controversies that have marked out the story of age-related fertility decline by taking into account the winners and the losers as if science was a battle field

(Haraway 1991b; Latour 1997)[38]. Rather the goal here is to question the "naturalizing effects of statistical knowledge production" (Schultz 2015: 345) and the resulting obviousness of the relation between age and fertility, by examining how the variable "age" is produced and transformed in relation to fertility and ARTs. To do so I document the practical and material efforts of demographers and epidemiologists in order to identify, objectify, and quantify the effects of "age alone" on fertility. In other words, I explore how they isolate age from other variables considered as bias in a search for the "natural" fertility decline and focus on their difficulties when they try to accomplish the positivist ideal of finding the laws of natural fertility. The attention paid to their ongoing efforts to stabilize the category of age-related infertility allows me to highlight how its reality is not separable from the tools and techniques used to enact it (Mol 2002), as well as to point to the impossibility of separating nature from society and to the weakness of purification processes (Latour and Woolgar 1996), when it comes to the relations between age and fertility.

The chapter focuses on three key moments where knowledge about age-related fertility decline is produced through different research apparatuses: historical data, sperm donation programs and IVF. The first section examines the emergence of the notion of "natural fertility" in historical demography and interrogates the naturalization of the fertility decline. The second one shows how age is isolated as a statistic variable and gendered in studies on sperm donation. The third section examines the role of IVF and shows how age is transformed from a statistical variable into a predictor to be used in clinical practices in epidemiological studies. The examination of these three moments will show how difficult it is to isolate age, or find "age alone", as a statistical variable in relation to fertility, but also how elusive is the search for "natural" fertility in spite of its obviousness and pervasiveness in the scientific and medical fields of reproduction.

As the reader will certainly notice, these three cases are all primarily taking place in the French context, even though they are also inscribed at the same time in the more global space of science. I did not decide to focus more on the French context, than on another one, but I followed the traces of the statistics of the age-related fertility decline in the scientific literature and focused on studies that were highly cited as marking out milestones in the production of knowledge about this category and it happened that several of them take place in the French context. I will not elaborate on this specificity but it can be assumed that it is not a coincidence, as demography holds a special place in France, especially in relation to its pronatalist politics as a social state (Rosental 2003a).

[38] For a deeper discussion on the different levels of critique of demographic knowledge production see Schultz (2015).

3.1. Fertility as a demographic concept

If we look in a dictionary (MacMillan Dictionary or The Free Dictionary online), the term "fertility" has several meanings. It refers firstly to the ability to produce offspring. Secondly, it is associated with ideas of nourishing and growing life, when it describes the quality of a soil or the creativity of a mind to produce ideas. It can be understood thirdly in a demographic sense, as the birthrate of a population. Demography – etymologically from the Greek "description of the population" – is known to be the science whose object is the dynamics of populations (Le Bras 2000) and refers both to the administrative activity of registering data and to the mathematical work of the statistics elaborating on this data (Desrosières 1993).

As Foucault famously showed, the creation of "population" through statistics and demography is inseparable from the exercise of power, as it can be observed in the shift in regimes of governmentality, from sovereignty to the politics of the living, or biopolitics, that took place in the 18th century (for a critique see Curtis 2002; Foucault 1976). The elaboration of statistics is thus always related to a concern for action, and can be understood as an applied science (Desrosières 1993). At the core of demographic knowledge production is the need and the goal to find laws or principles underlying a certain population in order to know it better and thus make it governable. This biopolitical project generates thus a tension between the naturalized and the political dimensions of population, as it is paradoxically both a "natural apolitical fact […] and a central issue for state intervention" (Schultz 2015: 343).

While associated with the development of the nation as a "separate space of national economy ignoring complex relations of the global capitalist economy" (Schultz 2015: 343), the concept of "population" has the great advantage of having a flexible scale, and therefore capable of being reduced to a small number of persons or to extend to all the people on the globe (Le Bras 2000). It can thus refer to a group of women, of couples, or to people united in a community such as the nation-state or another political or cultural entity. Therefore, by having to select the defining boundaries of a community, demographical work contributes to creating a population, more than reflecting its pre-given reality (Le Bras 2000), but in order to do so an important work of standardization, coordination, and classification is required (Desrosières 1993).

The notion of population originates also in the epistemic shift from generation to reproduction that took place at the end of the 18th and beginning of the 19th century and that had as one of its most important consequences "the constitution of a supra-individual and supra-generational

perspective on living beings" (Müller-Wille and Rheiberger 2007, cited in Lettow 2015: 269). Therefore, the notion of population from the very beginning was enmeshed also with the "reorganization of kinship and gender relations according to the hierarchical model of sexual complementarity" (Lettow 2015: 268). It follows therefrom that the notion of "fertility" becomes a core apparatus through which both the reproduction of the population and the individual sexual reproduction are thought and organized.

In a demographic sense, fertility refers to the "rate of childbearing in a population" (Heffner 2004) and "denotes actual procreation" (Schwartz and Mayaux 1982: 404) in opposition to "fecundity" which designates the "capacity for procreation" (Schwartz and Mayaux 1982: 404) or in other words the "ability of men and women to bear children" (Leridon and Slama 2008: 1312) independently from the ability to give birth to a live child. Therefore, fertility rates describe statistically the number of live births in a given population. While the demographic study of mortality started in the 17th century with the counting of deaths by John Graunt, the study of fertility remained in the shadows until the end of the 19th and the beginning of the 20th century in a context of fears about the degeneration of elites, the future of populations, and eugenic concerns about races and social classes (Le Bras 1981; Le Bras 2000; Lettow 2015).

How does age become important in relation to the study of fertility? Age is basically defined as "the number of years that someone has lived", but it has also a more normative definition, as "the time of life when you are allowed by law to do something" or "the time of life when it is possible or typical for people to do something" illustrated by the following expression of "childbearing age" referring to a population of women (MacMillan Dictionary Online). In demography, age along with sex, is one of the main structural indicators allowing the study of the dynamic of populations through categories such as birth, fertility, or mortality rates. But what is age in relation to fertility and how are they both correlated? If today the association seems so obvious that a common dictionary refers to the age of childbearing women as exemplifying the definition of age, it has not always been the case, and the relation between age and fertility remains of a complicated kind, as we are going to see.

3.2. In search of "natural fertility"

The statistics circulating in scientific articles, such as the reference to the work of Menkel and colleagues, are based on historical or non-contraceptive populations and refer to the notion of "natural fertility". What exactly does this historical population refer to and why is it important? In

this section I would like to describe the quest for "natural fertility" by post-Second World War demographers, and the ways through which this notion is constructed. What is of special interest for me is to question what the "natural" of "natural fertility" refers to, in which way it contributes to the naturalization of the fertility decline, and in which way its relation to age is constructed.

To understand the notion of "natural fertility" we need to go back to the work of the French demographer Louis Henry and to the uncertainties raised by the post war baby boom. An interest in the growth of population has been of scientific concern since the end of the 18th century and the work of Malthus (1766-1834), who advocated for a better control of population growth in order to avoid the exhaustion of earth's resources[39]. It also originates in eugenics theories that developed in the first part of the twentieth century, both combining in the fear that higher social classes and races would reproduce less than the "dysgenic" ones (Le Bras 1981). In spite of this increased interest, the relation between fertility and population growth has been difficult to establish, in a mathematical statistics sense. This relation constitutes the object of study of two eugenic demographers and statisticians of the interwar period, the Italian Corrado Gini and the British Ronald Fischer, who were both interested in sorting out the natural from the human – cultural, social – impact on fertility, that is contraception, in order to limit births intentionally. They contributed thus in establishing a "racial theory of fecundity" (Le Bras 1981).

However the concept of "natural fertility" itself is defined by Henry and gains with his work a specific meaning and international visibility. The post-war unexpected rise in birthrates, while the trend was rather to a decrease in the previous decades, questions the ability of demographers to anticipate trends in the dynamics of populations (Rosental 2003b). Being able to predict the population growth or its decrease is not only a scientific concern about the available tools and the need for better ones in order to make more accurate previsions, it answers also a very specific concern about the governance of populations. Indeed, in the case of ascertained growth more infrastructures will be needed and social insurances, such as the family allowance, which were implemented in the 1920s in France might be put under great pressure (Rosental 2003b).

Henry develops his theory of the concept of "natural fertility" in several articles. The first one is a 1953 article entitled "Fondements théoriques des mesures de la fertilité naturelle" in the French *Review of the International Statistical Institute* (Henry 1953). Some years later, two additional articles come out, one in the French Journal *Population* (Henry 1961a) published by INED – l'Institut National d'Etudes Démographiques – and the other one in *Eugenics Quarterly* (Henry 1961b), a

[39] For further discussion on the "Malthusian matrix" see Schultz (2015).

Journal published by the American Eugenics Society. In these articles, Henry establishes the distinction between natural fertility and controlled fertility. "Natural fertility" is defined as "fertility which exists or has existed in the absence of birth control" (Henry 1961b: 81, quoted by Wilson and Pardoe 1988: 4), while "controlled fertility" refers to the "stopping behavior" meaning that people limit the size of their families, once they have reached the number of children they wanted (Henry 1961b; Wilson and Pardoe 1988). This distinction is at the core of Henry's work aimed at "the search for detailed information on fertility that was not influenced by deliberate birth control" (Wilson and Pardoe 1988: 4). Driven by the concern of being able to anticipate the future of a population, he is looking for a "natural" benchmark or standard curve against which other fertility patterns could be contrasted, and the current population transformations assessed (Rosental 2003b; Wilson and Pardoe 1988).

Yet, he faces a technical and methodological problem based on the lack of appropriate data to elaborate such a benchmark. Reliable data to develop statistics come from so-called developed populations which are associated with low birth and death rates and characterized by industrialization and a market economy. It turns out that these populations are also known to control fertility through contraceptive means, which means that fertility is influenced by too many factors external to biology to serve as a benchmark of "nature". On the contrary, populations where fertility is supposedly not controlled, in the so-called non-industrialized or developing countries, and which would meet the conditions enabling them to serve as the elaboration of a standard curve of fertility, do not provide reliable data. While constituting a very concrete research problem for demographic knowledge production, this distinction also reproduces the well-known hierarchical and racialized separation between the so-called developing or primitive populations, associated with nature, and the western developed populations associated with culture.

3.2.1. THE "MILK BOTTLE UNIVERSE" OF THE HUTTERITES

This problem was well known at that time, and other demographers in the US (Eaton and Mayer 1953; Tietze 1957) solved it by turning to the population of the Hutterites, a protestant sect native to Switzerland and Bohemia, who emigrated to Dakota in the US in the 19th century in order to flee persecution. The Hutterites are a living population with extremely good records of all life events such as birth and death, also called the "vital statistics". They live in bounded endogamic small communities, called Leut (Ingoldsby and Stanton 1988) and are opposed to any form of contraception for religious reasons. They follow the biblical commandment to "be

fruitful and multiply". By doing so, they are an example of a population "reproducing itself close to the theoretical maximum level of human fertility" (Eaton and Mayer 1953: 206-207) which is considered as a characteristic of "primitive" societies. These specific conditions make them a kind of human laboratory, or a "milk bottle universe" for studying fertility in an "ideal condition of control achieved only in the study of animals" (Eaton and Mayer 1953: 251), such as the study by the demographer Raymond Pearl's on "*Drosophila Melanogaster* in half-pint milk bottle" (Eaton and Mayer 1953: 251). Therefore they serve as an "ex post facto experiment in human biology" (Eaton and Mayer 1953: 206). While Eaton and Meyer are more interested in studying patterns of human growth in regard to Malthusian theories about the growth of population than in finding a benchmark of "natural fertility", the design of their study provides them with the perfect opportunity to sort out what is natural – biological – and what is cultural – e.g. frequency of sexual intercourse, social taboos, migration, birth control practices, marriage patterns. Underlying this assumption is the idea that the Hutterites are the closest of western societies to the natural conditions of fertility, but also that their high degree of homogeneity in socio-economic status, education level, and cultural beliefs, cannot be used to explain variations in the results.

During the inter-war period, when demographic sciences gained in importance, a woman's age at the moment of the birth of her child/ren became the crucial variable for calculating fertility rates (Le Bras 1981; Rosental 2003b). As the exact facts of reproduction were still not very well known at a scientific level and it was hard to separate what came from the woman, from the man, or from the marriage, demographers based their study of human populations on animal studies where marriage *a priori* plays no role, and focused increasingly on women's age in order to simplify calculations (Le Bras 1981). From a technical point of view, age can easily be calculated based on the date of birth found in registers. In the famous study by Eaton and Meyer (1953), age-specific birth rates in women and in couples, is two among many other aspects that they address, such as age and sex distribution, the completed family size, mortality rates or number of twins. They find that there is a slow and progressive decrease in birth rates until the fortieth year where it becomes more pronounced and approaches zero at age 49 (see graph below).

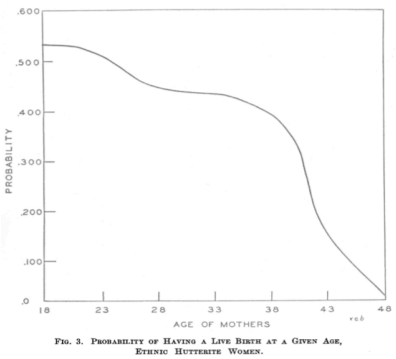


FIG. 3. PROBABILITY OF HAVING A LIVE BIRTH AT A GIVEN AGE, ETHNIC HUTTERITE WOMEN.

(Source: Eaton and Mayer 1953)

For the authors it reflects the decline in fecundity, but also a decreased level of sexual activity associated with aging and the duration of marriage. They also suggest that the steeper decline could be explained by impairment of the reproductive system following pregnancies and births, which is not the case for the Hutterites who increasingly benefit from good medical care. The later well-known study by Tietze (1957) grants the variable age a greater importance by focusing uniquely on fertility and sterility, and shows also a decrease in the number of births with Hutterite women's age. On the one side the high fertility rates of the Hutterites tend to prove that women can have children very late in their lives, but on the other, the fact that fertility declines even when a population reproduces itself to a maximum also gives to the decline a sense of ineluctability.

3.2.2. HISTORICAL POPULATIONS AS A PROXY FOR "NATURAL"

In order to overcome the technical problem of finding reliable data for a population whose fertility is not controlled, Henry opts for a different solution. He turns to historical data on past populations which, like the Hutterites, have the advantage of having reliable data and of not controlling their fertility. Following the work of his colleague Pierre Goubert (Rosental 2003b), he is especially interested in the possibility of using church records for the period before the 1789 revolution, and civil status registration for the period thereafter. By collecting data such as date of birth of parents and children, date of baptism, marriage, and death, he is able to construct "family data sheets"[40] and to retrace some fertility patterns. His technique is slow and tedious, but bears fruit and attracts funding (Rosental 2003a; Rosental 2003b). Due to the slow process involved, this technique works only for small units of population such as a village or a small community. The best known examples are the Geneva Bourgeoisie and his monograph on the Normandy

[40] "Fiches de famille". Translated by the author.

village of Crulai (Gautier and Henry 1958). Chronological age, or the number of years since a person has been born, is calculated in relation to the date of birth found in registers and is used in an unproblematic way, in order to identify fertility patterns, but does not constitute so far an object of study in itself. What is observed is that instead of having the same rate of births until their sudden cessation at menopause, the spacing between births becomes broader at the end of the reproductive span of women, and fewer women achieve pregnancy. That can constitute the sign of a reduction in fecundity, but can also be explained by other factors.

In the first phase of his work, Henry reconstructs the statistics of these small communities, but in a second phase, he starts a comparative project using data from different places and times, in order to identify patterns characterizing fertility uncontrolled by contraception or where the number of births is not intentionally limited (Rosental 2003b). One of the comparative works for which he is most famous is his work on the impact of age on infertility rates, based on data from 10th century England, inter-war rural Japan, Geneva, and French Canada (Henry 1961b). What is observed is that even if fertility rates vary greatly, the pattern of the decline is similar. Based on a cumulative logic and the calibration of the results taken from various contexts, repetition of similar patterns allows the testing of the model, as well as of the method. The use of data taken from different areas and from different times gives a sense of universality to the statistics. Through comparison out of space and time, natural fertility is therefore enacted as a biological phenomenon independent from other socio-economical factors.

However, what is interesting in Henry's work is that his concept of "natural fertility" comprises both a biologising dimension, and a pointing towards the limits of demography for grasping "natural fertility". He wants to elaborate statistics which most closely reflect the reality of the biology of reproduction, in the sense of non-controlled, based on data from historical populations which are working here as a timeless proxy for the natural. However, he is conscious of the limits of demography for seizing this ideal natural benchmark and for providing explanations regarding the observed trends (Henry 1961a). This limit is associated with the kind of data upon which their demographic studies are based, that is, isolated "vital statistics" such as sex, birth, marriage, and death, found in parish records and civil registration, that do not give any qualitative clue to actual and intimate reproductive practices. Therefore, they can show some trends or patterns, but the explanations for them remain unknown. Henry is especially aware that many other factors may have an impact on the spacing of births and on the observed fertility decline, including environmental and social, breastfeeding practices, and also cultural taboos

regarding sexual intercourses proper to a society (Henry 1961a; Rosental 2003b)[41]. Demographic studies can observe statistical changes, but can only produce hypotheses about the reasons leading to the statistically observed fertility decline. The reasons, whether related to biological reproductive processes, or to sexual and health practices or more generally to socio-economic factors, remain thus at a hypothetical level.

Consequently, even though the notion of "natural fertility" is labelled "natural", what is comprised under this appellation covers biology in association with multiple other factors that might impact on fertility. At the end of his article in *Population* (1961a), Henry therefore concludes with a vision of historical demography and biology as auxiliary sciences and advocates for a greater complementarity between both disciplines with the idea that an increased understanding of biological processes such as the impact of breastfeeding on ovulation, women's age's impact on ovulation, or genetic factors might help to refine the tools and models of demography, and provide better explanations for the demographic trends.

While the definition and the application of the concept of "natural fertility" have been very much debated, and current research on age-related infertility takes very different directions, a reference is still made to demographic studies on historical or non-contraceptive populations, as evidence of a "natural", in the sense of non-controlled, fertility decline, but also in the sense of the closest to the "real" ability of couples to conceive. Additionally, while the goal of finding what is "natural" fertility proved to be complicated, this goal is still present in more recent studies. For example, in 2002, a multinational study of daily fecundity (daily probabilities of pregnancy) was conducted in Europe with 782 couples practising "natural family planning methods". It aimed to objectify the effects of age on women's and men's fecundity and fertility with the goal of separating the effects of aging – nature – from the frequency of sexual intercourse – culture, society – (Dunson, Baird and Colombo 2004; Dunson, Colombo and Baird 2002). These cases show that while age can easily be identified and used as a statistical variable, as it is one of the easiest types of data that can be calculated by accessing the registers, to isolate the impact of "age alone" on fertility turns out to be more complicated, and can give very different results, as for example the study just mentioned provides reassuring results regarding the importance of the age-related fertility decline in women. The great availability of age and its naturalized dimension reinforce its obviousness as a crucial variable, but contrast with the elusiveness of the search to isolate its impact on fertility, which characterizes most studies on age-related infertility.

[41] In the same direction, another important element that is pointed out as missing, years later, is that pregnancy losses that can explain a decline are not reported and thus not taken into account (Larsen and Yan 2000).

3.3. Controlling the male factor

Associated with the taken-for-granted nature of the fertility decline that I found in all the discussions with medical experts, is the assumption that it is a woman's specificity, in opposition to the effects of age on male's fertility, which are recognized, but are considered to be less steep and sudden. Comments such as "It is unfair, but it is the way it is" or "The biological clock is really a women's problem", "It is an injustice but we cannot do anything against it" were very frequent. When pronounced, these comments perform several characteristics of the fertility decline. They affirm that it is specific to female bodies, that there is a hierarchical difference between men and women regarding their respective fertility limits, but that this difference is essential and that nothing can be done to change it. While the gendered dimension of the fertility decline might seem so obvious, isolating the impact of women's age on fertility has not been easy. Indeed, women's age is one factor likely to have an impact on fertility rates, but many other factors can have an impact too, such as contraception, birth spacing, frequency of sexual intercourse, sexually transmitted diseases, male infertility, not to mention all the socio-economical and environmental factors. Therefore the correlation between age and female fertility, that seems so self-evident in statistics, is not easy to establish. How to ascertain that "age alone" has an impact of infertility and not the other factors? How to isolate age as an important determinant and to measure its impact? These questions are technically difficult to answer and constitute the object of multiple studies.

Two questions in particular are often encountered in the literature. The first one asks how to differentiate the impact of women's age from the impact of men's age, and the second, how to ascertain that the fertility decrease is not due to a diminution of sexual intercourse in relation to the duration of the marriage. In other words how to isolate the impact of women's age on fertility? This is where some ARTs intervene by providing new kinds of data that can be used retrospectively in studies and by constituting a kind of laboratory where parameters that usually cannot be controlled in non-medically assisted conception, can be isolated to some extent in order to produce knowledge on age-related infertility.

3.3.1. Isolating the impact of women's age on fertility

A study marking a milestone in the production of knowledge on the age-related infertility decline, that is highly cited (for ex. in the opinion of ACOG and ASRM Committees 2014) and discussed, was published in 1982, in the renowned *New England Journal of Medicine*, by two French

statisticians, Schwartz and Mayaux, and a group of reproductive clinicians working in CECOS, the French Centres d'étude et de conservation des oeufs et du sperme humain (Schwartz and Mayaux 1982). The authors address the thorny question of knowing whether it is the diminished frequency of intercourse, male infertility, or the biology itself that matter in the fertility decline, a question left open by demographic studies. Their article is presented as a contribution to the study of "natural fertility" in the continuation of the previous demographic studies. The authors address the scarcity of data on "natural" reproduction, limited to historical populations, and propose to go further in the study of female natural fecundity over time, by using a sperm donation program with the goal of creating a controlled environment in which to study the "natural" age-related fertility decline.

In 1982 in France, IVF was only in its very early development, as the first so-called test-tube baby was born that same year, four years after the first test-tube baby in the UK in 1978. In contrast to IVF, sperm donation has been practised medically since the 1960s (Meirow and Schenker 1997). Technically it consists of inserting donated sperm directly into the vagina or uterus of a woman with the help of a syringe or a catheter. Its success is closely associated with the possibility of preserving sperm in good condition which was made possible through freezing and the creation of sperm banks, such as the CECOS created in 1973 (David and Price 1980). While sperm donation can be performed without medical assistance, it developed primarily in medical settings, and in France the organization of sperm donation programs was based on the model of blood donation with strict conditions of anonymity (David 2010a). The organization of the preservation and distribution of sperm provides a platform beneficial for the setting up of research. What changes in contrast with non-medically assisted conception, is that the quality of sperm can be assessed according to specific criteria, and that the moment of the insertion, and possibly of the conception, can be medically determined. These two elements that can be controlled provide the researchers with an opportunity to go further in the understanding of the effect of age on fertility rates, the sperm donation program being used here as a proxy for the natural fertility of women.

In contrast to Henry's concern about an unexpected increase in fertility rates and the need for tools to predict the population growth, the study by Schwartz and Mayaux (1982) is to be understood in the context of a growing concern about women postponing childbirth, as the editorial of the article shows (DeCherney and Berkowitz 1982). The editorial's authors highlight the importance of studying the impact of age on fertility, "as a result of the changing roles of women" (DeCherney and Berkowitz 1982: 424) which was entailing that many were asking "whether to delay childbearing until their 30s in exchange for career development" (DeCherney

and Berkowitz 1982: 424). Thus knowledge about the impact of age on fertility is seen as crucial in order for physicians to give appropriate counselling about family planning and the risk of age related infertility, as well as to orient decisions on appropriate treatment. This example shows how a sperm donation program is used to produce knowledge about the impact of age on female fertility in response to a social and medical concern raised by the changing role of women in society, and especially the statistically observed trend to delay childbearing. What emerges as important in this editorial in regard to clinical practices is the need to identify a moment of steeper decline, after which women would be at risk of greater infertility, but also to clarify the reasons for decreased fertility in women, both elements remaining not clearly identified and unexplained. Thus at the same time that sperm donation provides potentially more means of increasing fertility by enabling infertile or hypofertile men – and therefore couples – to have children, it is also used to answer clinical and social concerns about the postponement of childbirth by giving new means of studying the impact of women's age on fertility.

At the level of the procedure itself, Schwartz and Mayaux mobilize several actors[42] who play a crucial role in the configuration of the study. They examine retrospectively the pregnancy results – not the live births – of 2193 women who entered a sperm donation program between 1973 and 1980. The husbands of the women who entered the program are totally azoospermic. This term designates the absence of sperm in the ejaculate and thus the impossibility for the husbands to play an active part in the fertilization process. These men, the first actors, by being totally infertile are thus excluded as the potential male factor having an impact on age-related pregnancy rates. The possibility of adultery, possibly biasing the results, is evoked but considered to be too minimal to be taken into account.

In contrast, women, the second actors, are assumed to be normally fecund on the basis of a physiological and radiological examination of the fallopian tubes and uterus, and of the basal temperatures that ensure that there is no ovulation trouble. Unlike men, women are supposed to reflect the normality and the naturalness of physiological processes. They constitute the material from which the laws of natural fertility can be derived. All sperm donors were similar in each woman's age group and the sperm frozen and controlled according to the same criteria. This leads us to the identification of a third actor namely donated sperm. By being medically evaluated and selected according to medical criteria, donated sperm cannot be used to explain a possible

[42] Drawing on actor-network theory (Latour and Woolgar 1996) and the concept of the "ontological choreography" by Thompson (2005) I include non-human elements as actors because they also have an agency in the production of scientific facts.

decrease in pregnancy rates. Therefore the male factor is controlled by excluding the azoospermic husbands, and by substituting them with medically controlled donated sperm.

Time is the fourth actor playing a part in this retrospective experiment. Inseminations were performed following the same kind of protocol, in the different centres involved in the study, including basing the optimal moment of the insemination of frozen sperm on the observation of the basal bodily temperature and cervical mucus. As a result, the frequency of sexual intercourse is excluded as a possible factor impacting on pregnancy rates. Additionally, all pregnancies were taken into account independently of the outcome – possible miscarriages are not taken into account – and the cumulative success rates were calculated after 12 cycles, the duration of treatment and the repetition of cycles being important elements possibly impacting on the results of the study.

Other actors, less visible, but playing an important role nevertheless, are the registers enabling the coordination and standardization of the procedures among centres. They especially enable the record of the medical procedures performed, including the number of cycles and their outcome which can then be counted and correlated. The computer and mathematical formulas, where data are entered and calculated in order to produce final statistics also play an important role. Finally, the medical teams themselves, as well as the technical aspects implicated in the preparation of sperm and of the woman's bodies, while left in the shadow are of course also playing an important part in this research. By choreographing (Thompson 2005) these actors, this research device allows the researchers to control the variable of the male factor, that is to say, to exclude it from the variable impacting on pregnancy rates.

To identify how women's age impacts on fertility, the researchers divide the women into four age groups, 25 years old or younger, 26 to 30, 31 to 35, 35 or older. Their results show that there is a slight but significant decrease in fecundability, defined as the conception rate per cycle after age 30, which becomes more marked after age 35. The probability of success for 12 cycles, which was 73% and 74% for the two groups of women under 31 decreased to 61% for those aged 31-35 and to 54% for those aged over 35.

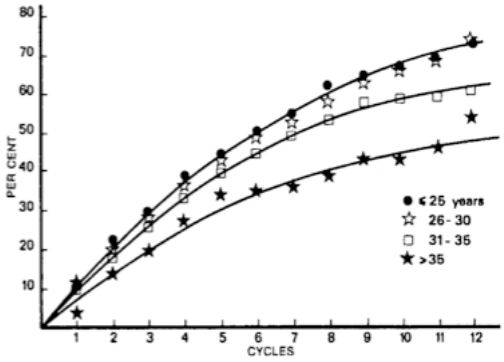


Figure 1. Theoretical Cumulative Success Rates in the Age Groups.

The four curves differ significantly ($P<0.01$). Because the curves of the two younger groups were similar, they are represented by a single tracing. These curves differ significantly from those of the two older groups ($P<0.03$ for those 30 to 35, and $P<0.001$ for those over 35).

There were 371 women in the ≤25 group, 1079 in the 26–30 group, 599 in the 31–35 group, and 144 in the >35 group.

(Source: Schwartz and Mayaux 1982)

3.3.2. *IN VIVO* AS IN NATURE OR IN CULTURE?

In the editorial, the decline in fecundity observed after age 30 is described as striking and the authors even suggest that "new guidelines for counselling on reproduction may have to be formulated" (DeCherney and Berkowitz 1982: 425) in order to include these results. The conclusion of this study and the editorial accompanying it were criticized as creating a false sense of alarm for women over 30 (Bongaarts 1982) and several biases were pointed out. The limit of 12 cycles was criticized as too short and as not taking into account the fact that older women may take more time to conceive, but in the end will nevertheless be successful (Bongaarts 1982; Menken, Trussell and Larsen 1986). The apparatus of the research setting itself was criticized as well. While it is used to create controlled conditions for the study of natural female infertility as reflecting the reality of biology, the use of frozen sperm and the medical conditions of conception are criticized because it is assumed that they cannot be compared to and produce less good results than non-assisted conception (Bongaarts 1982; Menken, Trussell and Larsen 1986). In other words, by trying to isolate the effect of women's age on natural fecundity, Schwartz and Mayaux produce retrospective *in vivo*[43] results, supposedly reproducing nature, but that cannot be compared to results in non-medically assisted reproduction, and therefore that are rather similar to culture. Taking a sperm donation program as a proxy thus would not work, as the medical control itself is considered as a bias in the search for natural fertility patterns.

[43] From Latin, means "within the living" and refers to experiments that are performed in whole human beings, in contrast to in vitro, ("within the glass") experiments, that take place in the laboratory on body parts such as cells, or tissues.

Especially critical towards the perceived alarmist views of the age-related fertility decline, Menken, Trussel, and Larsen published a highly cited study on age and fertility in *Science* (Menken, Trussell and Larsen 1986) and in the edited volume *Aging, Reproduction, and the Climacteric* also published in 1986 (Menken and Larsen 1986). They returned to Henry's data to examine the historical evidence that fertility changes with age in populations with no control over family size. Turning to ten different historical non-contraceptive populations in a comparative way allows them to highlight the great variability among age-related-fertility patterns and to put into perspective the results obtained by Schwartz and Mayaux (1982). They especially showed that childbearing at an older age had been practiced long before, due to the postponement of marriage, and that there was no overall decrease of fertility at a population level due to the postponement of childbirth (Menken and Larsen 1986). However, even if the fertility level varies, the age pattern of decline remains similar. In comparison with fertility rates of women aged 20-24, there is an average reduction of 6% for women 25-29, 14% for women 30 to 34, and 31% for women 35-39 (Menken, Trussell and Larsen 1986), which is less dramatic than the results of the French study (Schwartz and Mayaux 1982), but still a sign of decline. The question of knowing whether the observed decrease in fertility relates to marriage duration and age, is due to a decreased sexual activity and reproductive impairment associated with more pregnancies, and/or to the aging process itself remains however open.

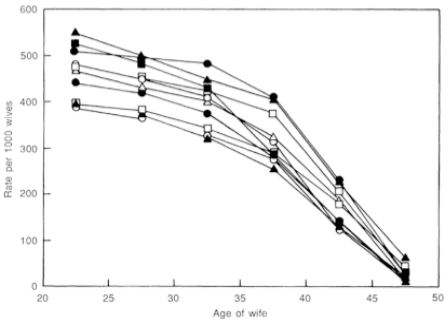


Fig. 1. Marital fertility rates by 5-year age groups (*5*). The ten populations (in descending order at age 20 to 24) are Hutterites, marriages 1921–30 (▲); Geneva bourgeoisie, husbands born 1600–49 (■); Canada, marriages 1700–30 (●); Normandy, marriages 1760–90 (○); Hutterites, marriages before 1921 (□); Tunis, marriages of Europeans 1840–59 (△); Normandy, marriages 1674–1742 (●); Norway, marriages 1874–76 (□); Iran, village marriages, 1940–50 (▲); Geneva bourgeoisie, husbands born before 1600 (○).

(Source: Menken, Trussell and Larsen 1986)

What is interesting is how historical data on fertility produced by Henry and colleagues are mobilized in the debate raised by the article by Schwartz and Mayaux (1982). Are statistics reliable or not? Are they telling the truth of the biology, or are they lying and creating a false infertility panic? This case shows that these questions are not new. The reliability of statistics to be the spokesperson (Latour and Woolgar 1996) of nature, in the sense of the biology, of women's

fertility is put into question by scholars in the field themselves. Instead of trying to isolate women's age-related fertility decline *in vivo*, the authors mobilize historical data, supposedly reflecting the reality of fertility non-controlled by contraception, drawn from different settings in time and place, as well as contemporary data, in order to put into perspective and relativize the results of the French team. In this debate, historical populations and sperm donation programs are competing as the best candidate to work as a proxy for nature. While Menken, Trussell and Larsen (1986) mobilize historical data to criticize the worrisome steepness of the decline given by the results from sperm donation programs, later their own results are themselves mobilized to assert the serious reality of the natural fertility decline, such as in the Heffner (2004) article or in the ACOG and ASRM Committees (2014) opinion.

In spite of these debates, the idea that sperm donation programs provide better conditions of study than "naturally selected populations" for studying the natural age-related fertility decline was maintained, as shown for example in a 1991 study published by a Dutch team (Noord-Zaadstra et al. 1991). Like Schwartz and Mayaux, they use a sperm donation program operating in two different clinics from 1973 to 1980 and 1986 respectively, to control the confounding factors of diminished sexual activity and male subfertility. In addition to the previous study, they aimed at identifying the age of the start of the fall in fecundity, also called "critical age", as well as the probability of pregnancy leading to a healthy baby. The study does not provide an answer to the crucial question "how long can a woman wait?" (Noord-Zaadstra et al. 1991) and other possible confounding factors are identified, such as the effects of smoking, alcohol, and coffee. Therefore, this example shows how by trying to isolate age as a variable, other "biases" are thus produced in an elusive search for "natural" fertility, which escapes the statistical framework.

More generally, Noord-Zaadstra and colleagues inscribe their study in the concern of providing women postponing childbirth with better counselling regarding reproductive issues. Here again, a sperm donation program is used to produce knowledge about age-related infertility, and especially to find a "critical age" marking a steeper decline in order to answer a concern raised by social transformations. With sperm donation programs, age becomes more than just a statistical variable. The variable "age" becomes gendered and becomes critical information used in counselling women and in orienting treatment when needed. While in the first studies on natural fertility women's age is one statistical variable among others, here it becomes the main object of study itself, and becomes inseparable from fertility. Passing from the study of populations to the social and medical concerns of preventing infertility and giving appropriate counselling to women delaying childbirth, that is to say, at risk of facing infertility problems, transforms age from an

unproblematized statistical variable into a "critical age" indicating when the risk of increased infertility become higher. Age in statistical relation to fertility becomes the answer to the nagging question of "how old is too old" (Heffner 2004), or "how long can you wait" (Menken 1985) that is asked over and over in scientific and public discourses.

In these studies the "natural" age-related fertility decline refers to what would happen on average without any technological intervention. The normative and non-interventionist dimensions conflate in this understanding of nature. Yet in "nature", age cannot be isolated as a variable. The different elements potentially involved in the fertility decline cannot be disentangled. For example, as conception requires the union of male and female gametes, it is difficult to know whether the decrease in fecundity is to be related to women's or men's aging, or both, or to other factors. While in the first case, historical populations are used as a proxy for natural fertility, meaning without contraceptive control, here sperm donation programs are used as another proxy for natural fertility, and as a technical apparatus enabling the isolation of the impact of women's age on fertility. What is paradoxical, is how the search for natural fertility takes place in the framework of assisted conception with the idea of creating a controlled environment where possible bias can be identified and neutralized, in other words how knowledge about "natural" fertility can only be produced in the highly controlled setting of the fertility clinic working here as a retrospective *in vivo* experiment. However, even though some possible biases seem to be under control, other biases are constantly identified, showing how elusive is the quest for "natural fertility".

Another aspect that certainly plays a role in the gendering of age, is that the question these authors want to answer is framed from the very beginning as a woman's problem. To ascertain the critical age of the fertility decline is useful only regarding the idea that the postponement of childbirth is a woman's problem and that women need accurate information to make informed reproductive decisions. There is therefore some circularity in the argument because the gendering of the postponement of childbirth and its consequences in terms of infertility, considered problematic socially and medically, leads researchers to focus their studies on the isolation of the effect of women's age on fertility, which in return contributes to feeding the anxieties about the risk of facing infertility when postponing childbirth.

3.4. Taking IVF into account

The development of IVF and the keeping of records on each treatment performed both provide useful data to assess statistically the impact of women's age on fecundity. Especially in France, the implementation of the FIVNAT epidemiological registry – created in 1986 by IVF pioneers to evaluate their activities, and to which most of the reproductive centres are affiliated – provides data on large cohorts of patients undergoing reproductive treatment[44]. The new set of data opened a new frame and provided new conditions for correlating age and fertility statistically. ARTs and age-related infertility can be related in two different ways that I want to explore now. The first one is that through the production of new data in the IVF setting, age as a statistical variable in "natural fertility" is transformed into age as a predictor of IVF success and failure, and as a projection in the reproductive future of specific individuals turning to ARTs to have a child. The second one is that the development and increased use of IVF raises the question of its possible impact on fertility at a general population level. In the first case, age becomes increasingly crucial as a predictor in the clinical setting, while in the second case IVF is seen as potentially influencing fertility at a general population level by enabling couples to have a child instead of remaining childless. In both cases, I will show that age emerges as an obstacle to the success of IVF and as a reason for its limited impact on fertility at a population level.

3.4.1. Age as a predictor

In 1990, a study by the epidemiologists and clinicians Piette, de Mouzon, Bachelot and Spira (Piette et al. 1990) analysed the impact of women's age on pregnancy rates with IVF. Drawing on the observation of the fertility decline in historical population and in sperm donation studies, as presented above, age is here considered and accepted as a prognostic factor of pregnancy success rates in IVF. Using the large scale data provided by French reproductive clinics – 5590 cases during the year 1986 – the authors try to specify and refine statistically the impact of age on pregnancy rates (all included, miscarriages not taken into account). They proceed in two steps. Firstly, the influence of women's age on the success rates is studied. Success rates are measured in two different ways, as the ratios of the number of pregnancies out of the number of attempts, and as the ratio of the number of pregnancies out of the number of effective transfers. In order to refine the understanding of the age-related fertility decline processes, the authors take into account three additional elements to which IVF gives access: the effect of age on the number of

[44] See their website: http://www.agence-biomedecine.fr/Registre-national-des-tentatives - accessed on August 20, 2015.

oocytes produced and retrieved in a cycle; the rate of negative oocyte retrieval; and the number of embryos transferred (the number of oocytes that developed successfully).

Secondly, the effects of what they call confounding factors such as the husband's age, infertility diagnosis, the mode of stimulation, and rank of attempt are considered and mathematically measured. By using a computer model where all data are entered, and by mathematically controlling co-variables, they isolate the effect of women's age on success rates and check that these confounding factors do not have any significant impact on success rates. They observe that the decline persists even when these factors are taken into account.

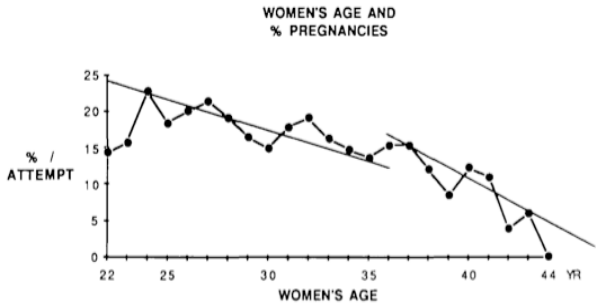


Fig. 1. Graph representing the relationship between women's age and pregnancy rates.

(Source: Piette et al. 1990)

After observing that their results confirm the age-related fertility decline, already observed in previous studies on historical populations and on sperm donation programs, they find that 37 years is the age marking an increased decline. They conclude that their study supports three hypotheses explaining the fertility decline. The first one refers to the decrease in oocyte production related to a poor response to hormonal stimulation. The second one points to the decrease in implantation rates, explained probably by some uterine dysfunction. The third hypothesis refers to the reduced viability of the embryos obtained related to the rise in miscarriages. Indeed, they observe that age is correlated with a reduction both in oocyte production, and in embryo implantation.

In this study, age is neither just a chronological age variable correlated with rates of fertility in a given historical or non-contraceptive population, nor just a "critical age" indicating when women are at greater risk of infertility: it becomes a prognostic factor of success rates based on statistical results and providing a specific individual turning to ARTs with information about chances of success based on women's age. The power of statistics and probabilities can be observed in the passage from the population level to the clinical level, where they are used to elaborate

recommendations. While intended to provide individual women with information about success rates in correlation with age, statistics are based on a given population and remain what they are. Statistics. That is a probability of success and failure, without taking into account the specifics of each individual. They describe a potential for reproduction on an average. They do not say anything about the individual ability to carry a child with or without medical assistance, nor about the exact biological mechanisms of the decline that remain to be studied.

Additionally, using IVF as an apparatus to produce knowledge about the age-related fertility decline gives access to the biology of the fertilization and implantation processes, biology against which demographic knowledge production has stumbled so far. Therefore, if it tends to biologise age, it also complicates it, IVF providing a new means of separating or dividing age. It opens up the possibility of distinguishing between different aspects of age – here oocyte production and embryo implantation – and gives new directions for research. In this sense IVF is an apparatus enabling the production of knowledge about the age-related fertility decline by providing more data, but also by giving more insights into the biological processes of reproduction themselves, the ones that Henry called for when facing the limits of demography. IVF thus contributes to biologising the relationship between age and fertility, but also to complicating it in the sense that instead of having the biology of the age-related fertility decline in general, the biology of the uterus, the biology of the oocytes, and the biology of miscarriages all emerge as important dimensions of age-related infertility.

3.4.2. CAN IVF COMPENSATE FOR AGE-RELATED INFERTILITY?

IVF can be used in another way to produce knowledge about age and fertility, not bringing age in relation to success rates in the clinic, but the other way round, by integrating IVF into the calculation about fertility declining with age and the postponement of childbirth. The statistically observed trend to postpone childbirth, along with the concern about the age-related fertility decline, is associated with the emergence of concrete and practical questions such as: "What are the chances of a woman of a given age conceiving within a certain period of time or never? If she is pregnant, what is the probability of delivering a healthy child? And if she cannot conceive without medical assistance, how would ARTs help?" These questions are addressed by the French demographer Leridon (2004: 1548) in a famous article entitled "Can assisted reproduction technology compensate for the natural decline in fertility with age? A model assessment" published in *Human Reproduction* in 2004.

This article shows well how IVF intervenes in the traffic between the social and demographic concern about the postponement of childbirth and related possible increase in female infertility and the development of biotechnologies impacting possibly on infertility. On the one hand, IVF provides new means for producing knowledge about age-related fertility decline and thus for answering questions valid for a general population of women, as well as for a population of women facing difficulties in having a child. On the other hand, IVF is integrated as a new technique potentially having an impact on declining fertility rates due to the postponement of childbirth in the general population. These two facets can be read in the goal of the article presented as justifying the study, which is of promoting a more efficient "familial planning" and providing more accurate information on the potential risks of postponing childbirth beyond a given age.

In this article, Leridon creates a virtual cohort of 10^5 women and reconstructs via a computer simulation the "reproductive biography of a woman" (Leridon 2004: 1549), from the age of marriage considered as "the starting point for exposure conception" to the menopause around the age of 50. He uses historical "vital"[45] data collected by Louis Henry on the French population between 1670 and 1830 in parish registers before the Revolution and on the civil register after it. For this study, Leridon focuses on marriages occurring before 1790 and restricts the sample to 3508 "completed families", which means that the marriage partners were still alive and living together at age 50 years. This criteria is important in order to obtain "unbiased" data on women's age at the last birth, to determine the "age at onset of permanent sterility", a concept referring to "the age after which a women is unable to conceive and to deliver a live birth" (Leridon 2004: 1549).

Leridon uses this data as a base for calculating probabilities that will be entered into the computer model called Monte Carlo. He takes into account several probabilities: the age-related monthly probability of conception, in other words, the fecundability rate, and the probability of miscarriage or live birth. Other elements taken into account are the time span when no conception can occur, during the pregnancy and afterwards, and the age of permanent sterility, which occurs before the menopause. The interval between marriage and first birth is also integrated into the model, and is associated with the age-related fertility decline. Since data on foetal loss did not exist in historical registers, he enters data from contemporary populations. For each reproductive biography entered in the model, some events – conception, miscarriage or live birth, age-dependent sterility – are attributed randomly for each month according to these

[45] Refers to birth and death dates of spouses and children.

probabilities. To reduce the bias related to the random aspect of the model, a very large virtual cohort of women is created. His results show that success rates are 75% for women starting attempts to conceive at age 30, 66% at age 35 and 44% at age 40 years. If a delay of conception of 4 years is integrated, the rates are even better and respectively: 91%, 84%, and 64% (see figure below).

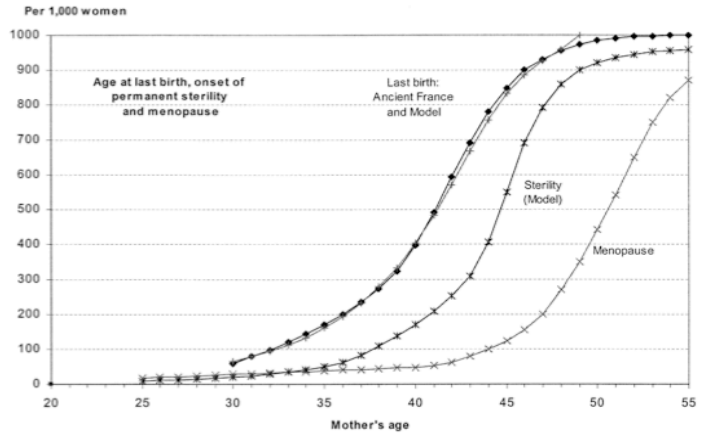


Figure 3. Cumulative proportions of women by age at last birth (historical French data and results of the model), at onset of sterility and of menopause. (Sources: Henry's survey, INED: Séguy, 2001; Treolar, 1974; and present author.)

(Source: Leridon 2004)

Leridon constructs first a model of "natural infertility" based on historical data from Henry, mixed with present data on miscarriage rates, and then in a second step, examines whether ARTS might have a significant statistical impact on fertility rates and could compensate for the age-related decrease in fertility. He draws on historical data to have probabilities on fertility and fecundity under "natural conditions" that is to say without contraceptive control and assumed to be the closest to the biology of women. Historical data are used here again as a proxy for "natural fertility", but are put to work through a computer model and mathematical formulas, in order to be combined with IVF success rates, and to produce knowledge on the impact of IVF on the age-related fertility decline. The computer model works here as an apparatus where data from different times and places can be combined, and a virtual population invented and easily multiplied to meet the demands of statistical calculations.

Leridon considers that ARTs would help hypofertile couples and sterile couples (for example in the case of blocked tubes) who would stay childless without them, but he concludes that ARTs would only partially compensate for the age-related fertility loss. He consequently recommends that women under 35 "be patient", the time to conceive can be longer but they have good chances of becoming pregnant, and that women over 35 "be impatient", because ARTs will not

fully compensate for the fertility decline and the miscarriage rates will increase. In order to weight these results, he stresses the fact that non-contraceptive populations did not know how to enhance their fecundability. On the contrary, nowadays peoples can use knowledge about fecundity – most favourable moment for conception, volitional factors (Rothman et al. 2013) – to increase their fecundability, understood as "the monthly probability of pregnancy among sexually active non-contraceptive couples" (Leridon and Slama 2008: 1315). The observation that ARTs only partially compensate for the fertility decline contributes to making age an obstacle to the success of IVF, at the same time that IVF is coproduced as a powerless tool to compensate for the postponement of childbirth at a population level.

Based on the observation that in historical populations, meaning under "natural fertility" conditions, the last birth occurs around 10 years before the menopause, Leridon "derives empirically" the age at onset of permanent sterility – median age at 44.7 years – to explain the discrepancy between the age of menopause and the age at last birth (see figure 3, above). He creates thus a distinction between the menopause and the age of permanent sterility occurring before menopause, producing a grey zone of fertility decline that he tries to objectify and quantify. Therefore what would matter is not the age of the menopause itself, but the age of permanent sterility that comes earlier in life. In an article of 2008, he goes back to this age of permanent sterility, and argues that results depend on the way in which infertility is defined, as the absence of conception or as the absence of live births (Leridon 2008). If fecundity is taken into account, and not fertility – live birth rates – then statistics are more reassuring. However this reassurance is counterbalanced by the fact that even if there is conception, the probability of miscarriage remains high.

The last case presented in this section shows how IVF plays a crucial role in the production of knowledge about the relations between age and infertility through a computer model, but also how while the search for "natural fertility" is not a goal of the study any more, data taken from historical populations not controlling contraception circulates and is mobilized in order to create a new population of women, and new results used to counsel women on the planning of their reproductive lives and on the possible help they might expect from IVF when they reach a certain age. It highlights the power of "natural fertility" to work as an "immutable mobile" (Latour 1987) and to circulate independently from time and place, as well as to be combined with other data through a computer apparatus.

Intermediary remarks

This chapter has documented the efforts of demographers and epidemiologists to correlate age and infertility statistically. While the relationship seems obvious and is part of public discourses on the postponement of childbirth, it has shown how difficult it is to isolate the effect of "age alone" and to correlate it with fertility. Animated by the positivist ideal of "the milk bottle" and the question of what would be the natural fertility patterns if humans could be observed in a bottle or in a lab like animals, post-war demographers have searched to discover fertility patterns non-influenced by contraception or other socio-environmental factors, historical populations working as a proxy for "natural". Later, sperm donation programs have been used as an apparatus working as an *in vivo* model with which to correlate retrospectively women's age and pregnancy rates, and control the male factor, as well as the confounding factor of sexual intercourse frequency. Finally IVF and computer models provide a new frame in which to isolate age and correlate it to fertility, "natural fertility" being here mobilized and combined with contemporary data to create a virtual population of women for testing questions about the relationship of IVF with age-related fertility decline.

In the studies presented, nature is to be understood in the sense of non-controlled by human volitional behaviour, to suppose that it exists, but also in the sense of the closest to the reality of the biology of reproduction. While the goal of these studies is to isolate the effect of age on fertility under "natural conditions" and thus from other possible socio-cultural determining factors considered as biases, other biases are produced to the extent that the research apparatus itself is pointed out as biasing the results, as shown in the debates on the sperm donation programs. Additionally, as the social cannot so easily be controlled, it seems impossible to grasp the effect of "age alone". Behind the apparent simplicity of age, defined chronologically as the number of years passed since birth, its complexity is revealed when studies try to correlate "age alone" with fertility. In this sense, demographic studies constitute an attempt to seize the reality of the biology, but constantly stumble against it, in their inability to seize biological processes. They open the door to the understanding of biological processes, but in themselves, remain limited to the study of a certain population, of statistical average.

Age is also transformed in its relation to fertility. In the first studies presented, age is only one variable among others, but then increasingly become the main object of study. It becomes a "critical age" after which the risk of being infertile increases, it becomes a predictor or a "prognostic factor" of success and failure rates, it becomes the amount of time one should wait

before consulting reproductive medicine specialists, and when one would have to "be impatient" and turn to IVF. In short, age in statistical relation to fertility becomes an indicator supposed to orient the reproductive lives of women.

In this chapter, I have also highlighted how "natural fertility" is produced first in response to a concern about the future of human populations, and secondly in response to the social and medical concern about the postponement of childbirth and the possible infertility risks that it entails. The statistics of age and fertility are not dissociable from the social concern about the future of population and the desire to govern population dynamics. What characterizes the development of IVF and statistics on the relations between age and fertility this medical procedure enables to produce, is their key role at this interface between society and medicine. The social concern is framed as women's problem, and the efforts of scientists are turned towards the isolation of the effects of women's age on fertility, results which in return feed anxieties about how long to wait before having a child, and how old is too old for women. IVF holds a very ambiguous position in this regard. On the one hand, it enables the production of more knowledge about age-related fertility decline, in order to understand better its mechanisms, because it allows the decomposition of its components and the control of some specific elements, working as an *in vivo* model. On the other hand, it is unable to compensate for the age-fertility decline at a statistical level, age becoming an obstacle to the power of IVF to act on the decline whose importance is increased by the trend to postpone childbirth.

Finally, the chapter has shown how the statistical reality of the age-related fertility decline is dependent upon the technicalities that enable its production. When statistics circulate, as "immutable mobiles", it is a statistical reality that circulates. While the end product of difficult and long work and of selective processes, while promising to reflect faithfully the reality of the fertility decline, it remains a statistics in the sense that its technicalities cannot be totally erased. The statistical device is still present when one speaks of the reality of the age-related fertility decline. It enables on the one hand its easy circulation and mobilization in various contexts, but on the other, it transports with it its weakness in accounting for the reality of individual biologies, chances, and risks. This is where the next chapter will lead us, as it engages with the biology of reproductive aging and documents the shift from age as a statistical variable to aging as a biological process occurring in specific body parts.

4. Locating age in the eggs

It is a sunny afternoon and I am talking with a Swiss reproductive biologist. We are in his office, seated at his desk covered with papers, with a computer standing on the side. He starts our discussion by presenting to me the last FIVNAT report (Limoni 2012), which collects and reunites data from the 25 Swiss reproductive medicine affiliated centres. We are both leaning over the screen of his computer, as he selects the graphs that he finds important to show me. The first graph shows how the age of women starting reproductive treatment is getting higher and how the overall number of IVF cycles has regularly increased. This expert associates the greater importance of the number of treatments with broader knowledge and greater acceptance of IVF in the public, resulting in people turning to medical assistance more readily. The second graph he comments on for me, without relating it directly to the first one, displays a decrease in success rates when they are correlated with women's age. He sighs with discouragement saying that as a biologist he has never seen any pregnancy after 45 years of age, and that one just has to forget about it.

He then explains to me how women are born with a fixed pool of oocytes that starts to deplete at the onset of menarche, and which will be totally exhausted at the menopause. He makes it clear that this pool will be decreasing years before the menopause. As a biologist, he can observe that the number of oocytes that can be retrieved in an IVF cycle, fertilized and implanted, is getting increasingly lower with age. He then relativizes this information by explaining that sometimes young women are already undergoing ovarian failure, and that sometimes 40 year-old women are just responding very well to the hormonal stimulation, which means that they produce more eggs than what he would expect for their age. He concludes by saying that there is "**age itself**" which is here to be understood as chronological age, the amount of years passed since one's birth, and "**physiological age**" which is rather to be understood in relation to the biology of the ovarian reserve. To illustrate his point, he turns back to his computer and shows me pictures of oocytes that he took during IVF cycles.

A "good" looking egg (expected to be high quality) from a 32 year old woman

Picture of another low quality, oocyte from a woman over 40
Polar body is visible at 10 o'clock

(Source: Pictures taken from the Advanced Fertility Center of Chicago, http://www.advancedfertility.com/ivf-egg-pictures.htm - accessed on March 18, 2014)

He comments on them:

> *Dr. H: When we have young women's eggs, they are wonderful, it is immediately visible, they are magnificent, they are round.*
>
> *NB: So you can see it as a biologist?*
>
> *Dr. H: Oh yes, there is no comparison between the eggs of a young woman and the eggs of an older woman, it is completely different.*
>
> *NB: How do you see the difference?*
>
> *Dr. H: The difference, we can look at it, it is visually, morphologically. […] Eggs of older women tend to be deformed like this one. The zona pellucida is a little different and more granular. […]*
>
> *(Dr. H. 20.02.2012).*

We proceed then to discuss the complexity of assessing eggs' quality and of relating it to pregnancy success rates and to age, complicating the apparent obviousness of this visual and morphological difference between young and old oocytes. The visual immediacy of the cells on the screen makes the difference between young and old, as if it was "the thing itself" (Franklin 2006), whereas the biologist's explanations recall for me that social values associated with youth as beautiful and smooth, and aging as ugly and irregular, are not separable from the way these oocytes get to be known, drawing my attention to the apparatus through which "young" and "old" are assessed through a scale of quality[46] and get embodied in the cells themselves.

[46] For a discussion on the different notions of quality – biological quality (morphological and genetic), quality of life, and population quality – see Wahlberg 2008.

This moment of discussion highlights also how different understandings of age are mobilized in relation to fertility decline in women. The biologist starts with the age of women when they turn to medical assistance for reproduction, then moves to age as a statistical variable correlated with success rates of IVF, after which he shifts to the ovarian reserve declining in quantity and quality with age, which leads him to draw a distinction between "age itself" and "physiological age", to end up by stressing the visual and morphological evidence of cellular aging, age becoming embodied in the reproductive cell itself. In this moment, he mobilizes the multiple versions of age in relation to fertility that move along different scales: population, clinical, individual, ovarian and cellular. Additionally, he expresses well the uncertainty created by the possible discrepancy between these versions, and especially between age as a chronological measure, and aging as the biological processes affecting reproductive cells.

We have seen in the previous chapter how chronological age is used as a statistical variable that can be correlated to fertility rates. It has shown how difficult it is to isolate and correlate statistically the effect of "age alone" on fertility at the level of selected populations – historical, sperm donation, IVF – working as proxies for the "nature" of the age-related fertility decline. It has also highlighted how these statistics are both powerful in their circulation and constant mobilization, and weak as they aim at reflecting the reality of the biology of fertility as unaffected by contraception and birth control, but are limited by this very biology that escapes the statistical framework. In contrast with the chronological age of the statistics, this chapter focuses on the biologisation of the relation between age and fertility and aims at understanding how age becomes located in the female reproductive cell or the oocytes, and not in other body parts, in a way that enables the biologist presented above to speak about young and old oocytes, as if the oocytes themselves are of a certain age. I am here interested in the making of "old eggs" (Friese, Becker and Nachtigall 2006) or "aged oocytes", entities related to the notions of "ovarian reserve" and "ovarian aging", that are related to chronological age, but are also different.

I consider the "old oocyte" as an entity resulting from the traffic between the reproductive and regenerative sociotechnical projects (Squier 2004) and as playing a key role in the passage from age – chronological, statistical – to aging – the biological processes of aging themselves. In the logic of anti-aging medicine that has emerged in the 1990s and which targets aging processes instead of age-related diseases (Mykytyn 2006b; Mykytyn 2010), it becomes necessary to identify the locus of aging – body part, cells, cell component or processes, environmental factors – in order to be able to act on it, to slow it down, or even to reverse it. In other words, in order to make older female bodies reproductive, or to make reproduction functional at older ages,

identifying the locus of aging is a necessary condition for reproductive biotechnologies to work as anti-aging technologies. However, locating age is not an easy task, as reproductive aging proves to be a moving target, rather than a static one.

This chapter reviews some milestones in the genealogy of "old eggs" by focusing on the role that ARTs play in the production of knowledge, and therefore in the targeting of reproductive aging. It questions also some of the effects engendered by the biologisation, and "molecularization" (Rose 2007) of age, less at the level of the subjectivities – an aspect explored in the second part of the dissertation – than at the level of the biology itself, drawing on the idea that "before changing what it is to be human, […], biotechnology changes what it is to be biological" (Landecker 2007: 232).

4.1. Transfers

By retracing the emergence of "old eggs", the centrality of the apparatus of "transfer" has emerged. Etymologically from latin, "trans" – "across, over, beyond" – and "ferre", "to carry" (The Online Etymology Dictionary), the verb transfer refers to the action of "*conveying from one person, place, or situation to another (move, shift)*", " *causing to pass from one another (transmit)*", and "*transforming, changing*" (The Online Merriam-Webster Dictionary). At stake are the two key notions of displacement and transformation. In order to deepen our understanding of the notion of "transfer" I would like to turn to Franklin's exploration of the world of transbiology.

Transbiology can be defined as "a biology that is not only born and bred, or born and made, but *made and born*[47]" (Franklin 2006: 171) and includes broadly "contemporary tissue engineering, regenerative medicine, cloning and stem cell science" (Franklin 2006: 176). In these scientific fields the distinction between biology and technology becomes blurred, as biology itself works as a technology. Furthermore, biology as the object of study and the experimental apparatus studying it are not separable (Franklin 2006; Franklin 2013a). This exploration has lead Franklin to highlight the importance of the "**trans**[48]-work" of the embryo and of the "**trans**lation" processes in the expanding platform of IVF and stem cells research, characterized by its **cross**ing of the clinical-scientific divide (Franklin 2006). In this context, one of the definitions of the prefix "trans-" is "the literal back and forth of the *labour* of creating new biological" (Franklin 2006: 174). It refers both to the traffic between the clinical and the scientific settings, and to the **"trans-**substantiation" processes through which embryos pass from being the own intimate

[47] Italics are in the original text.
[48] Emphasis added.

property of couples into a cell-line which "becomes part of a shared, collective commitment to scientific progress" (Franklin 2006: 175).

Rereading and applying Strathern's work on "merographic connections" in stem cell research, Franklin reflects on the movements and stasis at work in knowledge production and practices, that she refers to as "analogical work", and that are useful to deepen our understanding of the notion of "transfer". The concept of "merographic connections" is developed by Strathern in *After Nature (1992a)* to describe the way that domains, such as nature and culture, are both similar and dissimilar according to the connections made between parts and wholes and to the angle from which these connections are made (Strathern 1992a: 72-81). This concept is useful to understand how "the meaning of facts can be changed through connection to different contexts [different wholes]" (Franklin 2014), as well as to stress the constant shifting between parts and wholes and the mingling together of different domains, that are transformed in the process. By developing the notion of "analogic return" or "analogical work", Franklin focuses precisely on the back effects or looping feedbacks of these moves and on the ongoing reshaping, rescaling and redefinition of the objects, techniques and knowledge circulating in biomedicine and biosciences.

Drawing on Franklin's conceptualization of the "trans-work" taking place at the interface of the IVF clinic, I want to show how the apparatus of "transfer" was already at the core of the traffic between the reproductive and regenerative sociotechnical projects before the most recent development of transbiology. I argue that it precedes these biotechnological developments, but constitutes also a condition of possibility for them, specifically in the production of knowledge on reproductive aging. To do so I draw on the study by Friese and Clarke (2012) of similar "trans-work" in the history of reproductive sciences. They document and analyse the role of modeling and animal models in the development of the sciences of reproduction from the beginning of the 20th century to the last development of "somatic cell nuclear transfer"[49] in endangered animals. They coin the concept of "transposition" to capture "the ways in which models create dynamic and iterative connections between different kinds of things, people, and organizational sites" (Friese and Clarke 2012: 33) and to describe "the back and forth relationships between different lines of work, different spaces and different "species"' bodies that occur in modeling practices (Friese and Clarke 2012: 34).

[49] Refers to what is commonly called "cloning" techniques, see Friese (2013) and Franklin (2007) for in-depth analyses of these techniques.

Drawing on their conceptualization, I define "transfer" as the displacement and transformation of bodily, epistemological, and technical parts from one setting to the other, and along different scales. Through transfer a part stays itself and is transformed at the same time. Through transfer the part is transformed but also transforms the whole to which it belongs. Its ontological status changes (Mol 2002), but transfers leave traces of their passage and connections can be made. I am interested in these subtle movements of similarity and difference, and especially in their crucial role in the production of knowledge on reproductive aging. I am therefore especially interested in the ways that transfers are made productive in terms of knowledge production and new entities, both being not separable. I use the term "transfer" and not "transposition" (Friese and Clarke 2012) to stress more the materiality of the "object" being transferred, than the effects of transposing models from one species to the other.

The goal of this chapter is thus to situate and document the emergence and the production of the notion of ovarian aging by focusing on the role of ARTs in this process. It especially aims at highlighting the modalities of the different transfers marking out this genealogy and at questioning their effects on the generation of "old oocytes". After retracing several historical elements contributing to this emergence, I will focus on two technologies – egg donation programs and ooplasmic transfers – both aiming at extending female fertility and "revers[ing] the natural decline in human fertility" (Sauer, Paulson and Lobo 1992). I will show how these two technologies, both potentially reproductive and anti-aging, work as an "*in vivo* model" (Navot et al. 1991a), enabling the production of knowledge on reproductive aging as a medical and scientific object by contributing to the localisation of age in the eggs.

I will then question the effects of this localisation and of the subsequent biologisation of the relations between age and fertility. I will show how it contributes to the complexification of the notion of reproductive aging by dividing it into several bodily, cellular, and molecular components, and how quality becomes a central notion, at the expense of quantity. I will also highlight how the localisation of age in the oocytes becomes a condition of the possibility of acting medically upon it. Finally, I will show how paradoxically, by focusing on the quality of oocytes, which becomes a central notion, environmental factors are reintroduced into the notion of ovarian aging.

4.2. Aging ovaries

The idea of "aging ovaries" is not new, as shown by the following quotation from the reference work on mammalian ovaries by Edouard Van Beneden, a Belgian zoologist and embryologist. He is known as the first one to describe the process of cellular meiosis (Hamoir 1992; Vallade 2013) and refers himself to the work of the famous German anatomist, Heinrich Waldeyer (1870):

> *Waldeyer starts his book on the ovary by saying: "If one wants to describe a mammalian ovary exactly, one must above all take into account the age of the organ". Nothing is truer: the shape, the volume, the colour, and the structure change over the life course; but these changes are not only the result of an age-related progressive transformation of the organ, similar notable modifications happen periodically: they are in relation with the rut and the gestation*[50] *(Van Beneden 1874: 465-476).*

According to this quotation, the idea that aging affects mammalian ovaries at several levels – shape, volume, colour, structure – is already present at the end of the 19th century, but Van Beneden hastens to point out that even though variations can be observed after the organs in question have been removed from "sacrificed animals", then cut, impregnated with two reagents, indurated, and coloured, in order to be examined under a microscope, the distinction between aging and other yearly cyclical variations is not possible to establish.

Following this initial experimental work, reproductive biologists spent the end of the 19th and the first half of the 20th century trying to understand oogenesis – the creation, development, and production of oocytes – and to remove ovaries from several kinds of non-human mammals, weigh them, slice them, taint them, try to differentiate several kinds of follicles, observe them, count them under a microscope, and sometimes correlate these observations with age (e.g. Flemming 1885 studying cell death in the rabbit ovary; King 1916 studying age and fertility according to the litter size in the rat; Mandl and Zuckerman 1951 studying the oocytes' decrease in rats; Rolle and Charipper 1949 studying the effects of advancing age on the histology of the uterus, ovary, and vagina of the female golden hamster). They observed that the number of follicles decreases with aging, but debates focused more on the temporality, or the moment – before or after birth – when this production ceases (Allen 1923; Allen and Creadick 1937; Arai

[50] Translated by the author. The original quotation is: "Waldeyer commence son livre sur l'ovaire en disant : "Si l'on veut décrire exactement l'ovaire des mammifères on doit tenir compte avant tout de l'âge de l'organe." Rien n'est plus vrai: la forme, le volume, la couleur, la structure se modifient dans le cours de la vie; mais ces changements ne sont pas seulement le résultat d'une transformation progressive de l'organe amenée par l'âge, des modification notables se produisent périodiquement: elles sont en rapport avec le rut et la gestation".

1920; Swezy 1933; Vermande-Van Eck 1956), than in understanding the relation of the decrease with age per se.

4.2.1. HUMAN OVARIES UNDER THE MICROSCOPE

I found[51] the first occurrence of the notion of the "aging ovary" as such, in regard to humans, in an article by the pathologist, Arthur Hertig, published in 1944 and entitled "The aging ovary – preliminary note" (Hertig 1944). Working at the Department of Pathology and Obstetrics, Harvard Medical School, and the Free Hospital for Women, Brookline, Massachusetts, Hertig begins his article by mentioning that a more extensive study was initially planned, which intended to examine 500 cases of women over 45, but was interrupted by the war, leading him to present only first results based on his day-to-day observations[52]. Working directly on human oocytes is difficult and was rarer at that time than it is today. Therefore research was developed mostly on non-human mammals, mainly rodents[53]. However, as a pathologist working in a clinic "devoted to elective gynaecologic surgery", Hertig had the opportunity of examining the morphological features of a lot of reproductive material, namely ovaries, removed from surgery patients.

Important ideas are established in his paper. The first is that the ovaries age on a time scale which is different from the other organs: they age at a different speed. Based on the observation that there is no new addition to the "ovarian capital" with which females are endowed at birth, he writes: "The aging of the ovary in one sense really begins at birth and continues throughout life" (Hertig 1944: 581). In this way, ovarian aging becomes an integral part of the development of human females. While the rest of the body develops, ovaries will already start to age.

A second important idea is that visually, the morphological appearance of the ovaries changes in such a way that he claims that he is able to ascertain the age of the woman through the observation of the morphological features of her ovary. A strong association between the visual state of aging of the ovary based on its morphological assessment and the chronological age of the woman is thus established.

Finally, the third important idea is the observation of an inter-individual variability. While he claims that there is a strong link between the state of aging of the ovary and the chronological age of the woman, he also observes that "there are, however, the relatively infrequent patients whose

[51] Systematic research was performed with the databases PubMed, Web of Science, and Google Scholar. The keywords employed were: "ovarian aging", "reproductive aging", "senescent ovary", "aged oocytes", and "aging ovary".
[52] In the article, there is no mention of the technical aspect of his work and no indication about the different patients the examined ovaries were taken from.
[53] For a discussion about the role of animal models in reproductive sciences see Clarke (1998) and Friese and Clarke (2012).

ovaries resemble those of a woman ten years her junior" (Hertig 1944: 582). Interestingly, these three preliminary ideas – the relative premature aging of ovaries compared to other bodily organs; the distinction and correlation between the age of ovaries and the age of the woman; the interindividual variability and the resulting gap between ovarian aging and chronological age – can still be found in more recent studies.

A few years later, Erik Block, a gynaecologist from the Department of Women's diseases and the Histology Institute of the Karolinska Institute in Stockholm, Sweden, combines histological and statistical methods in order to evaluate the variations of the number of oocytes according to age (Block 1952). Facing the same difficulty of finding human ovaries unaffected by pathology, he focuses his analysis on 43 autopsy cases of women aged 6 to 44, whose cause of death – suicide, acute illness, or accident – cannot explain these variations. He counts three distinguishable kinds of follicles – primordial, growing, Graafian – on slices of ovaries. While noting the important interindividual variability, he is able to show that after age 38, there is a correlation between chronological age and the number of primordial and growing follicles that can be established by statistical calculation. However, he concludes that "no definite relationship between age and the number of [Graafian] follicles in the ages eighteen to thirty-eight" can be shown (Block 1952: 120). Therefore, at the same time that a relation between chronological age and the number of follicles is established, it also proves to be weak and not so conclusive, at least until 38 years old.

Hertig's and Block's works show how research on the human "aging ovary" starts to develop in the post-war period, but is limited to material removed after elective surgery or autopsy. While the decoupling of chronological and biological age will become an object of study in itself in the late 1980s and 1990s[54](e.g. Alviggi et al. 2009; Bancsi et al. 2002a; Brook, Gosden and Chandley 1984; Toner et al. 1991a), here already, by attempting to correlate chronological age with observable, morphological and quantifiable transformations in the ovaries and number of follicles, these scientists start to instil a separation between these two kinds of age. However they do not express any direct concern for fertility and do not constitute aging as a problem. Hence they remain at the descriptive level of the morphology of ovarian aging. Interestingly too, the idea of "quality", which will become primary in the 1990s and later, is absent from these accounts.

[54] The focus on biomarkers especially led to the decoupling of ovarian and chronological age; for a deeper parallel discussion in the field of anti-aging medicine, see Moreira 2015.

4.2.2. Of mice and defective oocytes

A systematic research on Google Scholar, Pubmed, and Web of Science, using the key terms "ovarian aging" and "reproductive aging" shows that there is a slow increase in studies having these categories for their subject, mainly on non-human animals in the 1950s and 1960s[55], but that the overall number of publications remains relatively low[56]. However, another milestone that I could identify is the review article by Robert Noyes, from the Department of Anatomy and Obstetrics-Gynaecology of the University of Hawaii, on the "physiology of ovarian aging" published in 1970 in the Annals of the New York Academy of Science (Noyes 1970). Previous work (Noyes and Dickmann 1960) had led Noyes to study "ovular age", age there being understood in a different sense. In this previous article, Noyes understands "ovular age" as the time of development of the reproductive cell in regard to ovulation. He is interested in the timing between ovum maturation and endometrial development, and the lower and upper limits of time in order to obtain a pregnancy in rats. It is not the chronological age of the rat, but the age of the gamete itself – counted in days – which is under study, based on the observation that there is loss of reproductive capacity after ovulation[57].

In his 1970 article, in contrast, he is interested in transposing studies on animals to understand how to "prevent deleterious effects of aging on reproduction" in humans. This goal is inscribed in a concern about the possible rise in "Down's syndrome" frequency due to the postponement of childbearing, "in response to a widely felt need to decrease pressure in rapidly growing populations" leading humans to seek "ways to decrease their fertility" (Noyes 1970: 517). This demographic concern is presented as problematic more for its consequences in terms of Downs's syndrome frequency, described as a "disaster", than in itself, because birth control and associated postponement are rather seen positively. Underlying Noyes' review is a will of prevention by understanding the biology, or the physiology in his terms, of ovarian aging, by reviewing clinical and experimental data on "ovarian and ovular aging in the context of dysgenesis" (Noyes 1970: 517). The latter term designates the abnormal or dysfunctional development of the ovum, which could start prenatally – "during the three or four final weeks of maturation in the embryonic ovary" – or postnatally – "over a forty years period as a result of mutational or cytoplasmic

[55] For example the study by Green 1957on the effects of advancing age on the histology and reactivity of the mouse ovary.
[56] A PubMed research performed on August 20, 2015, indicates that 6 articles were published in the 1970s having "reproductive aging" for the topic, while none are identified before then. Similar results are given with the keyword "ovarian aging". The use of the keywords "aging" and "ovary", less discriminantly, indexes 15 results from 1945 to 1959, 88 in the 1960s, jumping to 222 in the 1970s, and to 690 in the 2000s. The keyword "senescent ovary" was tested, but did not prove to work well.
[57] Interestingly, this specific understanding of "oocyte aging" as designating the cellular and molecular processes that occur in oocytes during in vivo, but also in vitro aging, independently from chronological age, with the goal of identifying reversal possibilities is also found in a more recent article published in *Human Reproduction* (Miao et al. 2009).

senescence in resting dictyotene ova" (Noyes 1970: 517). The mention of these two hypotheses shows that the effect of biological aging itself is left open, even though the relationship between chronological age and an increase in Down's syndrome frequency is the point of departure of the study.

The article presents several experimental hypotheses on the underlying processes leading to defective oocytes that could possibly be related to the trisomy of a chromosome. The association between aging and defective oocytes is understood in a genetic or chromosomal sense here. While a correlation between maternal age and the birth of "Mongolian imbeciles" had already been established years before (Penrose 1933), here the cause is researched in a defective oocyte, as the causal missing link between chronological age and the birth of children carrying a defective chromosome, to the exclusion of sperm which are not taken into account. Environmental or external factors such as a restrictive diet, the timing of intercourse, x-irradiation or viruses are taken into account as much as the cellular processes of aging itself, including cytoplasmic factor, meiotic division and resulting aneuploidy, or elements controlling cellular atresia, a phenomenon of cellular loss. Hence, there is no well-defined boundary between what would pertain to external or environmental factors, and what would be part of the biological process of cellular aging itself.

The author does not settle the argument between these two options and ends up with two main possible explanations of defective oocytes. The first one refers to the "production line hypothesis" (Henderson and Edwards 1968, cited in Noyes 1970), which assumes that oocytes produced late during foetal development would come to maturation and be ovulated later in life too. They would be more defective due to a short period of prenatal oogenesis when they would complete the first stages of meiosis and would therefore be very sensitive to external factors such as "radiation, drugs, and diseases affecting a mother" (Noyes 1970: 518).

The second explanation is that "chronic aging" or aging itself, would explain the presence of defective oocytes, and would be aggravated by "toxic damages" affecting the oocytes, produced prenatally, and then arrested in a fragile state of cellular division and remaining in the ovaries for about forty years. Whether aging is an "accessory factor" as Noyes calls it, that would potentiate toxic damages, or whether it is the primary process aggravated by factors taking place outside the body is not settled, and Noyes concludes that both may "share common biochemical mechanisms within the cell" (Noyes 1970: 523). The distinction is difficult to establish as these toxic factors can have an effect on the cell only through the passage of time and due to the state of arrest of oocytes, leaving them exposed to external elements over the years. Hence how to

differentiate the passage of time from chronological age and physiological aging remains an open question, and the boundary between the inside of the body or even the cell, and the outside of the body as the environment, proves to be fluid.

By locating aging in the ovaries and ova, Noyes leaves open what constitutes the aging process itself, the result of it being defective oocytes that can be explained by factors internal to the cell, or by factors external to the cell, both finally being, he assumes, likely to be very similar. This question, as well as the question of knowing whether defective oocytes are the results of prenatal or postnatal processes, may seem insignificant, but they matter considerably if the goal is, as in Noyes' case, to prevent the effects of aging on reproduction, in relation especially to the births of children affected by Down's syndrome. Trying to locate the source and the time of oocyte impairment opens up the possibility of targeting it and acting on the process, be it aging itself, or factors outside the body, whether prenatal or postnatal.

In this programmatic article, the study of ovarian aging processes is not separable from the will to prevent it, and to some extent from an oocyte rejuvenation project, which leads to a distinction between chronological age and ovarian age. Noyes presents several examples of rejuvenation. The first one is a restrictive diet imposed on mice that was able to extend their reproductive span (Ball, Barnes and Visscher 1947, cited in Noyes 1970); the second one concerns the selections of young and old marine invertebrates (Lansing 1959, cited in Noyes 1970), and the injection of RNA in defective ova (Salisbury and Hart 1970, cited in Noyes 1970), both showing the importance of cytoplasmic factors; and the third one is the transplantation of young ovaries behind the kidney capsule (Blaha 1968, cited in Noyes 1970; Blaha 1964). Trying experimentally to act on ovarian aging in rodents and make them reproductive enabled the identification of possible causes of aging. Targeting the right locus of aging is confirmed by the resulting evidence of rejuvenating effects and/or reproduction, such as the state and numbers of oocytes present in ovaries at an age when they should be depleted (Ball, Barnes and Visscher 1947), or the birth of healthy progeny in transplanted hamsters (Blaha 1964).

4.2.3. THE EMERGING NOTION OF QUALITY

In this example of the ongoing traffic between reproduction and rejuvenating technologies (Squier 2004), the handling and transfer of oocytes become crucial. Preceding the procedure of egg donation in humans, the experiments reviewed by Noyes account for several attempts to transfer aged ova to young female rodents and reciprocally, in order to determine the importance

of uterine and ovarian factors, both apparently playing an important role. The apparatus of "transfer" – of ovaries and cytoplasm – enables the targeting of the site of aging by being efficient in its rejuvenating effects, which is shown at a reproductive level, by the birth of offspring or the number of follicles. However, in contrast, the first example – the restrictive diet – also proves to be effective in its rejuvenating effects. It is an easily controllable external factor that eventually has an impact on mouse ovarian aging, even though it does not entail direct action on oocytes themselves. In addition, studies on mice are transferred into the human domain, in order to understand how aging might affect the production of oocytes.

Noyes' review therefore both establishes the importance of ovarian aging in the understanding of the production of defective oocytes, leading possibly to the birth of children with Down's syndrome, and highlights how undetermined these causes are, as it questions the temporality – the exact moment, prenatal or postnatal – and precise processes where ovarian aging takes place. Indeed, Noyes finishes his article by proposing new directions for research – other than aborting genetically defective embryos or childbearing when young, described as "effective, but not very practical measures" (Noyes 1970: 523) – focusing on "fundamental problems as the biophysics of meiosis, ovular cytoplasmic rejuvenation, and an atresia-controlling factor in the pituitary gland" (Noyes 1970: 523), directions which are still relevant nowadays.

In contrast with the two previous studies I presented (Block 1952; Hertig 1944), with Noyes' work we can see the importance of the notion of "quality" emerging in relation to the demographic trend to postpone childbirth. This trend is associated with the expression of a concern that is not about a fertility decline as a diminution of the number of children born at the level of the population, which is seen rather positively, but rather a possible increase in the birth rates of Down's syndrome children, that is to say a biopolitical concern about the health of future populations. We can observe in this case the emergence of the conflation between "biological quality", "quality of life" at an individual level, and "population quality" discussed by Wahlberg (2008). Noyes himself does not speak of quality, but of the reverse idea, "defective oocytes", which becomes the missing link between chronological age and the birth of children with chromosomal abnormalities. Therefore, the idea of quality seems to emerge in direct relation to the "quality" of children to be born, as a direct link between maternal ovarian material and the birth of "defective" children. However, the causal element making these oocytes defective is left open, even though it has to do with the temporality of years passing. Therefore, on the one hand, the relation between aging, defective oocytes, and the birth of Down's syndrome children is

strengthened, while on the other, the idea of ovarian aging itself is questioned, as it is uncertain whether aging or environmental factors cause defective oocytes.

Hence, knowledge transfer from mice to human, along with the transfer of ovaries and cytoplasm among mice, are productive in terms of knowledge as experiments on mice's ovaries are used to answer the social and medical concern about a possible rise in births of children with Down's syndrome and scientific questions about the impact of aging on defective oocytes. But they are also productive in terms of the generation of the new entity of "old oocytes" whose quality becomes central.

4.3. Egg donation as an "*in vivo* model"

While the number of studies on ovarian aging and reproductive aging has developed slowly since the 1950s, especially on non-human mammals, a sharp increase in the number of publications can be observed in the 1990s, and even more at the beginning of the 2000s. A research performed with PubMed indicates that the number of publications having "reproductive aging" for their topic increased from six articles indexed in the 1970s, including two on humans, to 180, including 103 on humans, in the 2000s, and 183, including 117 on humans, between 2010 and 2015. With "ovarian aging" as keyword, results show a similar trend, with 1 article in the 1970s, 82 in the 2000s including 73 on humans, and 149 between 2010 and 2015, including 92 on humans[58]. How can this significant increase be explained? And what is the role of ARTs in this trend?

Firstly, the demographically observed trend to delay first childbearing that can be "traced back to the early 1980s for most Western countries" (Prioux 2005) plays a crucial role in the constitution of "reproductive aging" as a social and medical concern. Constituted as a "growing public health problem" (Bentov and Casper 2013), "an age-related disease" (Tatone and Amicarelli 2013), and a "therapeutic challenge" (Klein and Sauer 2001), it is very often mobilized as a justification and legitimation of the studies on reproductive and ovarian aging mechanisms. It follows from that, that at the same time that a demographic concern regarding the postponement of childbirth has emerged, IVF has started to develop, providing new means of studying the biology of reproductive aging, as reflected in the publications on the topic in the eighties. However, there is

[58] The results are dated August 20, 2015. The research was performed with the keywords "ovarian aging", "reproductive aging", and "aging" "ovary", which proved to be less discriminant. A similar research was performed with the research engine Web of Science, giving similar results. The keywords "senescent ovary" and "aged oocytes" were also tested. While the first one gave poor results, the second one shows a similar tendency to increase, from 6 articles indexed in the 1980s to 47 in the 2000.

a significant and even more marked increase of publications in the 1990s[59], highlighting the importance of the expansion and diversification of reproductive technologies in the knowledge production on ovarian aging in humans. It shows especially how the social trend of postponement alone is insufficient to produce knowledge about the biology of ovarian aging, but alternatively how the scientific developments in reproductive biology are framed, fed, and legitimized by this very demographic concern about the postponement of childbirth and the related rise in infertility rates at a population level.

Indeed, in addition to the demographic concern, several changes – technical and material – contribute to make ovarian aging an increasingly studied theme of research in reproductive biology and related fields. Firstly, technological developments opened up new means of studying oocytes. IVF made accessible a greater number of living human oocytes for study *in vitro* than ever before (Picton, Briggs and Gosden 1998). Additionally, the development of transvaginal ultrasonography made possible their study *in vivo* in an unprecedented way (Reuss et al. 1996). Secondly, IVF, and especially egg donation, opened up the possibility of testing and measuring reproductive aging hypotheses (e.g. Navot et al. 1991a) in relation to implantation, pregnancy, and live births rates. With IVF especially the reliability of predictors or markers of ovarian aging could be tested. Such biomarkers include the hormones FSH (e.g. Lee et al. 1988) and AMH whose role as a marker for ovarian function was identified in the late 1990s (de Vet et al. 2002; Rooij et al. 2002; Visser et al. 2006), in addition to the antral follicle count (Chang et al. 1998; Reuss et al. 1996). Thirdly, the development of molecular tools (Picton, Briggs and Gosden 1998) has enabled the study of the aging process in the cell itself and the identification of proteins and molecules which may potentially play a role in reproductive aging processes (Dorland, van Kooij and Velde 1998; Velde and Pearson 2002), multiplying the elements that it is possible to manipulate in order to act on aging[60].

[59] Research on PubMed realized on August 20, 2015 with the keyword « reproductive aging » identifies two studies on humans (18 on humans and non-humans) from 1980 to 1989, and 32 from 1990 to 1999 (70 if not restricted to humans). Similar results are obtained with the keyword "ovarian aging". A complementary research on PubMed performed on December 7, 2015, with the keyword "ovarian reserve" identifies one article (restricted to humans) in the 1980s and 78 in the 1990s, illustrating a similar increase.

[60] It must be noted that in parallel, anti-aging medicine started developing in the 1990s too. The exact links between research on reproductive aging and on general aging during this decade still need to be studied. For more information on the history of anti-aging medicine, see Mykytyn's work (Mykytyn 2006a, 2006b, 2010).

In this section, I can unfortunately not explore all the aspects mentioned above and will focus on the crucial role egg transfer plays in the constitution of ovarian aging as an object of research and on the transformations resulting from it[61].

4.3.1. THE OVARY, THE UTERUS, OR BOTH?

Reproductive sciences have mainly built up knowledge by experimenting on and studying non-human animal models, especially farm animals, in order to improve breeding (Clarke 1998; Franklin 2007; Friese and Clarke 2012; Wilmot 2007a; Wilmot 2007b). However, as already shown in the previous section, knowledge about ovarian aging was mostly produced through the reproduction and sacrifice of rodents. In 1955 the anatomist Krohn had proposed "tissue transplantation" as a way of understanding and acting on "the ageing of the organs of reproduction" in mice[62] (Krohn 1955; see also Krohn in Zuckerman and Weir 1977). Studies published on rodents showed non-conclusive results, but generally the predominance of a "uterine factor" could be observed. For instance, the American and English anatomists Talbert and Krohn (1966) used ova transplantation to understand the mechanisms leading to a decrease in the litter size in aging mice. They implanted ova from young mice into older mice, and ova from old mice into younger mice, and observed that in the first case blastocysts did not survive well, leading them to conclude that the uterine environment was the predominant factor. These results were followed and confirmed by other studies reviewed by Stein (1985) and Klein and Sauer (2001).

While mice constitute a favourite animal model for understanding the effects of aging on reproduction due to their short reproductive lifespan and their age-related decrease in fertility (e.g. Brook, Gosden and Chandley 1984), the transposition of these observations to humans are not evident and in the 1990s several studies tried to identify what elements were responsible for the age-related fertility decline in women. Reproductive biologists tried to sort out what comes from the uterus, and what from the oocytes, as expressed in the following excerpt of an article by a Spanish team, published in *Human Reproduction*, on the effects of aging on the reproductive system:

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[61] Some interesting directions of research could focus on the understanding of how the very notion of the "ovarian reserve" which is constituted through the identification of biological markers conduces to an individualization of aging and the identification of individuals at risk. Another interesting direction might focus on the hormonal dimension of reproductive and ovarian aging. Finally, examining the ways studies on general or somatic aging and on reproductive aging more generally cross and feed into each other would be highly interesting.

[62] For a medical review of the history of transplantation in reproductive medicine see Nugent et al. 1997.

> *There is an evident decline in human fertility with age. The fundamental physiological question is whether the ovary, the uterus, or both are affected by the changes induced within the body by senescence (Pellicer, Simón and Remohí 1995: 77).*

Is the uterus or the oocytes, or a combination of both, responsible for the fertility decline? Or in other words does age or aging affect the oocytes's quality, subsequent fertilization and ability to implant, or the uterus and its receptivity to implantation? And if both are affected, which factor is more important in relation to fertility? The question is not insignificant and has implications for where to focus medical and technical interventions in order to increase pregnancy rates and to optimize the reproductive potential of women or couples, which is the main goal of reproductive medicine turned towards the making of babies, as the visible signature of their working (Franklin 2013a). This uncertainty about where to locate aging can be contrasted with the certainty that I was able to observe, when I met medical experts in Switzerland, based on the clinical evidence, that the oocytes are responsible for the fertility decline, or that age-related dysfunctions in oocytes explain this decline, and not the uterus. The following excerpt of an interview with a reproductive biologist, illustrates this point very well:

> *Look at the results, with egg donation they have always been incredibly good. You take any woman, you give her the oocytes of a twenty years old young woman and you obtain pregnancy rates of 40 or 50%. It has always been demonstrated, the uterus does not matter. You build an endometrium, you give it hormones, you prepare her, she is 66, you put embryos conceived with the oocytes of a very young woman and you obtain absolutely astounding pregnancy rates! (Dr. H. 20.02.2012).*

As highlighted in this excerpt, egg donation played a crucial role in the localisation of aging in the oocytes, and not in the uterus, to the point that for this expert it is just an empirical and taken-for-granted fact that age is in the oocytes, and that the uterus does not matter. The making of babies with donated eggs in postmenopausal women works here as the best and clearest proof of this assumption. I suggest that we return to this moment when the disambiguation of uterine and ovarian factors was not self-evident and that we try to understand how egg donation works here as an apparatus through which ovarian aging is materialized and objectified.

The first baby conceived through egg donation was born in Australia at the beginning of the 1980s (Lutjen et al. 1984; Trounson et al. 1983). The egg donation procedure is similar to a standard IVF, the main difference being that the procedure is divided between two women, the donor and the recipient. The donor undergoes hormonal stimulation in order to produce more

oocytes that the one or two usually released in a regular menstrual cycle. When they reach maturity, the oocytes are retrieved and fertilized *in vitro* with sperm. Usually the sperm is from the husband of the recipient, but technically it can also be the sperm of a donor. Once fertilized, the developing embryos are implanted in the uterus of the recipient, who will eventually carry the pregnancy, give birth to the child and raise it. As in IVF, conception takes place out of the human body, in the lab, but in contrast to IVF, the oocytes of the recipient women are substituted with the oocytes of a donor, entailing a separation between the genetic, gestational, and educational functions of motherhood, as very well documented and discussed in the literature (e.g. Kirkman 2003; Konrad 2005; Orobitg and Salazar 2005; Thompson 2005).

The first medical indications for egg donation are premature ovarian failure, unexplained or after chemotherapy, but it has been increasingly used to induce pregnancy in women aged in their forties and fifties (Sauer and Kavic 2006). At the beginning of the 1990s, several medical teams published articles on perimenopausal and postmenopausal pregnancies. Among the "pioneers" (Franklin 2013b), we can find in 1989, Ian Craft and Paul Serhal in England, who published in *The Lancet* the results of their egg donation program including 11 women over 42 out of 61 women (Serhal and Craft 1989). In 1990, Dr. Sauer and his team at the University of Southern California, Los Angeles, reported preliminary results on an egg donation program for women in their forties, in the *New England Journal of Medicine* (Sauer, Paulson and Lobo 1990). Three years later, in 1993, in *The Lancet*, they reported their results on pregnancies induced in women in their fifties (Sauer, Paulson and Lobo 1993). The same year, in Italy, two teams, that of Dr. Antinori in Rome, and that of Dr. Flamigni, in Bologna, presented their results on egg donation programs and pregnancies in women up to aged 61, in the journal *Human Reproduction* (Antinori et al. 1993; Flamigni 1993). Starting with women in their forties, the studies published by these medical teams present results of increasingly older women, as if in a competition for the highest age records. While the extraordinary cases of the upper range are still highly controversial, the success of egg donation in women in their forties and in their fifties contributed greatly to the spread and increased use of the procedure (Sauer and Kavic 2006).

What do these oocyte donation programs, implemented in the clinic, enable scientists and clinicians to study? How are they used to improve the understanding of reproductive aging? How do they work as an *in vivo* experimental model? Especially, how are they used to address the question of uterine/ovarian aging? In 1990, the gynaecologist Abdalla and his team reported their examination of the first hundred cycles performed at the Lister Fertility Clinic, in London, between January 1988 and May 1989, on patients aged between 25 and 49 years (Abdalla et al.

1990). Trying to identify the factors impacting on the outcome of the procedure, they observed that the age of the recipient significantly affected the pregnancy rates, independently of the number of embryos transferred, dropping from 50% in the 25-29 age group, to 9.7% in the 45-49 age group, and that the age of the donor, mainly under 35, did not have any impact on these rates. These observations lead them to conclude that uterine factors have a greater impact on the age-related fertility decline.

However, three years later, they reached different conclusions (Abdalla et al. 1993). Using a larger sample of cases, they compared the pregnancy and miscarriage rates between two groups, women receiving donated oocytes, and women using their own oocytes, and observed that overall the two groups had very similar pregnancy, miscarriages, and live birth rates. Recipient's age, donor's age, indications for treatment, number of donated oocytes and of embryos transferred were not found to be significant factors impacting on pregnancy rates. However, they found that donor's age – between 21 and 39 – had an important impact on the miscarriage rates, shifting from 14% for donors between 20 and 24 to 44.5% for donors over 35. Additionally, when they restricted the comparison to women over forty, they observed that in the group of recipients of donated eggs, pregnancy and live birth rates were significantly higher and miscarriage lower, than in the group using their own oocytes. These statistics lead them to conclude that a decrease in the quality of oocytes is more important than the receptivity of the uterus in explaining age-related lower success rates. These conclusions were confirmed in 1997 in an article published in the journal *Human Reproduction*, entitled "The age of the uterus does not affect pregnancy and implantation rates" (Abdalla et al. 1997)[63].

Focusing more on the role of the uterus, and especially on the endometrium (the uterine lining), Navot and his colleagues working in New York tried to evaluate the relative importance of uterine receptivity and oocyte quality. They created two research designs to answer their questions in a prospective way, unlike the precedent studies where data are analysed retrospectively. By varying the hormonal protocols in donor and recipient cycles, but using the same source of oocytes, they tested whether it is the oocyte quality or the uterine receptivity that is determinant (Navot et al. 1991a). Regardless of the hormonal stimulation they used, Navot et al. observed that the endometrium could regain morphological integrity and its ability to be ready for embryo implantation. Pregnancy rates were similar in both groups, leading to the conclusion

[63] In this article, they compare the pregnancy rates between two different age groups – group A, 39 and under, and group B, 40 to 52 – of women sharing eggs from the same donors. Finding that the pregnancy rates are the same in both groups, and that the miscarriage and delivery rates are similar, they conclude that uterine aging does not provide a sufficient explanation.

that the embryo, and thus oocyte quality, is more important than endometrium receptivity. These results were confirmed by the comparisons between implantation rates in young donors and older (over 40) recipients that proved to be similar in spite of the age difference (Navot et al. 1991b).

Sauer and his team, based in Los Angeles, cast even more doubt about any role played by a uterine factor in infertility (Sauer 1997). Performing egg donation in postmenopausal women aged between 50 and 59 and who received hormone replacement therapy, they observed that the receptivity of the uterus could be maintained very efficiently, while at that age these women's oocytes could not be used any more, and oocytes had to come from younger women.

Pregnancy rates obtained with egg donation in women aged over 40 or even 50 vividly prove the importance of ovarian aging in fertility decline. When oocytes come from younger women, good success rates are obtained, compared to women of the same age using their own oocytes, leading to the conclusion that the effects of aging are located in the ovaries. Even if the effects of age on the uterus are acknowledged and that the uterus does age too (Erel et al. 2005; Pellicer, Simón and Remohí 1995), the fact that its morphological structure and its ability to sustain implantation can be preserved through the administration of high levels of progesterone (Meldrum 1993) makes it a less important factor. Therefore, the locus of aging is determined by the non-ability to act on it. Uterus and oocytes are both aging, as is the whole body, but through the administration of hormones, the uterine function can be "re-normalized", the administration of hormones making it meet the physiological norm, while the only way of overcoming ovarian aging, or in other words, the effects of age on ovarian function, is a substitution, a bypassing, or a circumvention: younger oocytes instead of older oocytes. This transfer confirms both the site of aging and a definition of aging as what cannot be hormonally "renormalized" or made functional.

4.3.2. (RE)PRODUCTIVE TRANSFERS

These examples show how oocytes transfer is not only a way of making parents and babies, but also a way of producing knowledge on the biology of reproductive, and specifically ovarian, aging. Through the transfers of oocytes, displacement and transformations are performed generating new connections and redefinitions that I would like to detail now.

Firstly, egg donation programs, when used as *in vivo* model, are at the crossroads of clinical and experimental research. They become a platform where research material is made available, but also an experimental setting where various hypotheses can be tested. The technique of IVF

enables the autonomization and circulation of reproductive substance independently from genealogical paths (Franklin 2013a) allowing the repartition of the procedure amongst different persons, as in the procedure of egg donation. In addition, IVF entails also a division and certain autonomization of the different stages of reproduction – oocytes maturation, fertilization, embryo development, and implantation – thus providing a privileged insight into them, which when combined with egg transfers between different groups – donors/recipients, younger/older – multiplies the possibilities for comparisons and correlations. Especially, by dividing the procreative process into many different steps it opens up new possibilities of relating age and fertility, and of locating the site of reproductive aging in order to target it biotechnologically. It thus confirms how porous are the boundaries between research and medicine in the field of reproduction, and how intense are the transfers between them, as clinical settings may be used to do research, or research might be done to answer clinical questions, as already shown in studies on the IVF stem-cells interface (e.g. Franklin 2006; Franklin 2013a; Haimes and Taylor 2011; Mitzkat, Haimes and Rehmann-Sutter 2010).

In this movement, infertile bodies or non-reproductive bodies, become productive in relation to knowledge about reproductive aging, as Navot et al. write: "Women with ovarian failure who receive donated embryos serve as a unique model for elucidating the complex interrelations of the ovary, endometrium, and embryo" (Navot et al. 1991a: 408). Bodies in need of assistance to become reproductive, are seen as productive in terms of research, not because they provide oocytes for research, but more basically, because of their very condition which enables the testing of hypotheses about what can lead to reproductive success or not. In other words, their condition enables the localisation of age in the body, through a transfer device. In this sense egg donation programs cannot only be seen as assisting reproduction. Combined with infertile women's bodies, they also become the fertile ground for producing knowledge about reproductive aging, to understand its mechanisms, to test hypotheses on its causes, and to situate it exactly. Egg transfers and infertile women's bodies become part of the same apparatus producing experimentally, retrospectively or prospectively, the entity of ovarian aging. In this sense, egg transfers are both reproductive – making babies – and productive – producing knowledge.

Secondly, egg transfer contributes to determine both the site of reproductive aging and the limit of biotechnologies to act on it, thus redefining reproductive aging, as what cannot be made functional again without a transfer or a substitution process. The centrality of this substitution process not only contributes to locate age in the eggs, but also to isolate it. Aging eggs become the predominant factor determining reproductive success at the expense of environmental factors

or of an individual's will. The localisation of age in the eggs can be read as a way of biologising the relation between chronological age and fertility. Age, as in the number of years passed since one's birth, becomes embodied and materialized in the reproductive cell itself. In return, the age of the reproductive cells might become more determining than chronological age in regard to success rates in IVF clinics entailing that its "true" age, the one that matters, is biological. However, this biologisation is also a condition of the possibility for acting on it. In their search to locate age in the body, reproductive biologists find that oocytes are the body part that is the most important through a logic of transfer, entailing that if age is in the eggs, eggs, as bounded "ex-vivo body parts" (Konrad 2005) can be substituted, replaced, but also maybe one day regenerated or rejuvenated, or made functional again, by understanding finely the aging processes taking place at a cellular level.

Thirdly, the localisation of age in the eggs creates a gap between chronological age and ovarian age that may be decoupled. Indeed egg donation programs mobilize both the chronological age of women and different age groups for comparisons, in correlation with IVF success rates. Ovarian age results from the statistics showing that the chronological age of the donor affects an oocyte's quality independently from the age of the recipient. This distinction generates a tension between chronological and ovarian age. On the one hand chronological age is necessary for establishing the existence of ovarian age, as it is constantly mobilized in the research device itself and in the evaluation of the results, the success rates of implantation, pregnancy, and live birth. In this sense chronological age is a necessary condition for the existence of ovarian age. On the other hand, once ovarian aging is produced and age located in the eggs, it can be decoupled to some extent from chronological age and gains an autonomous existence, becoming an object or a scientific entity in itself.

This tension reflects, for me, the specific material conditions of research on ovarian aging. The clinical apparatus, which uses chronological age as a standard element of evaluating and measuring success rates, becomes retrospectively used as an essential element of the research apparatus enabling the production of knowledge about reproductive aging. It also reflects the constant clinical concern with success rates, as animated by a very pragmatic search for what works and what does not when women get older. Even though egg donation works here as an experimental *in vivo* model for researching reproductive aging in humans, this model is also framed by a clinical logic turned towards success rates and having chronological age as the starting point from which to establish the existence of ovarian age.

Finally, egg transfers confirm the idea that oocytes' quality matters. By locating age in the eggs, it is not their quantity that matters, but their quality. The "quality" of the oocytes is understood as declining with age and as a factor explaining the decrease in pregnancy rates and the increase in miscarriage rates. Quality here is to be understood as the "quality of life" (Wahlberg 2008) in relation to the ability of the oocyte to fertilize, develop and induce a pregnancy, and in counterpoint to the greater risk of leading to a miscarriage. Instead of being directly understood in relation to the birth of a "defective" child, as shown in Noyes' review article, quality here becomes related on the one hand to the cell itself, its ability to develop, cleave, multiply, (all observable *in vitro*), and on the other hand to the success rates, the ability of the fertilized oocyte to implant in the uterus and induce a pregnancy, which can be statistically established. However, behind this probabilistic sense, what is quality, and how it is explained, requires a move to another level, inside the cell, as we are going to see now.

4.4. When quality matters

> *It is possible to be pregnant spontaneously at 45, but it remains an extreme minority. It is far from the rule and medicine has no answer for it, because the problem is the oocyte quality, and the oocyte quality is directly related to age, and there is no medical treatment that is going to improve it (Dr. B. 25.01.2012).*
>
> *In reality, the harsh reality of the thing, is that we do not have any diagnostic test to evaluate the quality of the oocyte. The only criteria we have to evaluate the oocyte quality is the age of the woman (Dr. C. 10.01.2012).*
>
> *The problem is that the egg has a chronological history. The egg, the more it gets older, the less good it is (Dr. E. 21.12.2011).*

These three excerpts of interviews with Swiss clinicians show how central the idea of quality is to the understanding of reproductive aging, and how strongly connected to age itself it is, in a way that tends to make age and quality equal. However, when questioned about the means to assess and objectify this quality in clinical practices, practitioners' answers become less clear. In substance, both the quantity of oocytes and their quality are related, but quality is more important, and quality is age, and age is quality. We have already met the entity of defective oocytes in relation to Down's syndrome in Noyes' review article (Noyes 1970), where oocytes' quality was related to the ability of the reproductive cell to produce not only good embryos, but also healthy – with no chromosomal defects – children. IVF and the egg donation programs played an important role in confirming that oocytes' quality matters in relation to success rates

and that it should be further studied. However how aging affects the oocyte's quality remains uncertain, and the question requires the examination of the inside of the reproductive cell itself.

What I want to show in this section is how the localisation of age in the oocytes entails a focus on oocytes' quality and how by focusing on age-related oocytes' quality, environmental factors are brought back into the picture. In this sense, the biologisation of chronological age, as ovarian age, does not entail a biologisation in the sense of an essentialization, rather it complicates the biology of ovarian aging by taking into account its various components at cellular, molecular and epigenetic levels, and by questioning, as Noyes did in his programmatic article, the impact of aging itself and that of the environment, that can be understood as elements out of the body, or as the microenvironment of reproductive cells.

4.4.1. BIOLOGICAL QUALITY?

As we have seen, oocytes' quality was first understood in relation to the birth of children with chromosomal defects, such as in Down's syndrome. The correlation between increased maternal age and the risk of having a child with Down's syndrome is older than the discovery of DNA and the development of biogenetics. For example, already by 1933, the research medical officer Penrose was drawing on the observation that "Mongolian imbeciles are frequently born to elderly parents" in order to research whether maternal and paternal age can be an etiological factor in this kind of condition (Penrose 1933). However, it was only in the 1980s that an increased number of studies focusing on chromosomal abnormalities were published, partly in relation to the development of ARTs in making an increased number of human oocytes and embryos available for research.

An important study conducted in the 1980s suggested that biological, rather than chronological age, was determinant for the risk of aneuploidy, which is an abnormal number of chromosomes resulting from a problem during the cellular division occurring in gametes to reduce the number of chromosomes by half (Brook, Gosden and Chandley 1984). These reproductive biologists performed ovariectomies on mice, which means that they removed surgically an ovary in each mouse. They showed that mice with one less ovary had an increase in aneuploidy rates. These observations confirmed a relationship between the state of the ovarian reserve – the quantity of oocytes remaining – which is reduced by half following the ovariectomy, and aneuploidy rates. Therefore they showed that biological age – the state of the ovarian reserve – is more determining, than chronological age per se. Further studies and especially the development of

molecular tools confirmed that older oocytes have a higher rate of aneuploidy, or of chromosomal aberrations, due to a problem of non-disjunction occurring during the cellular division process of meiosis.

While quality is most often understood in relation to these chromosomal defects, it also goes beyond it and it concerns more generally all the aspects potentially impacting on the oocytes' reproductive competence. Chromosomal defects in particular can be seen as the result of processes whose causes still need to be further studied. The results of egg donation programs focused attention on oocytes as the site of aging affecting their quality. But another kind of transfer – ooplasmic transfer – played a key role in the understanding of an oocyte's quality at a cellular level. This procedure to which I would like to turn now, confirms how important the tool of transfer is, as enabling the target of intervention to be situated, and acting on it.

4.4.2. OOPLASMIC TRANSFER AND ITS REJUVENATING EFFECTS

In 1997, Jaques Cohen and his team from the Institute for Reproductive Medicine and Science in Livingston (USA) and in Tel Aviv (Israel), reported the first birth of a living child after ooplasmic transfer in the prestigious medical journal *The Lancet* (Cohen et al. 1997). The mother was a 39-year-old woman with poor ovarian reserve and a long history of infertility in spite of many attempts and changes in protocols and techniques. Ooplasm is the liquid contained in the germ cell, where most cellular activities occur, called also the oocyte cytoplasm. In the procedure this cellular liquid is removed from a donor egg, and transferred into the recipient's egg, together with one selected spermatozoa from the husband. It was performed on 14 patients' eggs, out of which 9 patients' oocytes showed signs of fertilization and activation, and one ended up in a live birth.

This very experimental procedure was repeated (Cohen et al. 1998; Huang et al. 1999) and proved to have a rejuvenating effect on older oocytes (Tilly 2001). While it has never reached success rates as good as egg donation, is highly controversial (e.g. Darby et al. 2013; Hawes, Sapienza and Latham 2002), and now prohibited in most countries, it has been productive in terms of research on reproductive aging. Indeed, the relative success of ooplasmic transfer confirmed that the quality of oocytes could be improved by using young donors' oocyte cytoplasm. This procedure lead scientists to look for the specific components contained in the ooplasm that might have an impact on oocyte's aging and loss of quality. Among others they identified the key role of the increasingly visibilized mitochondria.

Mitochondria are essential structural components of cells – cell organelles – which are found in high numbers in oocyte cytoplasm (Bentov and Casper 2013). They are known to play a role in the production of cellular energy, in the control of cell death, and in the chromosome's segregation when oocytes resume meiosis (Kujjo and Perez 2012; Vaskivuo and Tapanainen 2003). They are transmitted only by the mother and contain a small percentage of DNA, called mitochondrial DNA[64]. The role of mitochondria in general aging had already been identified in the 1970s (Harman 1972), but its role in human reproduction has thus been put to the forefront by the experimental transfers of ooplasm.

These experiments enabled the determination that the site of aging might not be the oocyte as a whole cell, but a part of it, and that its functionality might be reestablished after injecting the ooplasm taken from a donated oocyte. Again the transfer of some bodily part or substance enables the localisation of age to be refined, not only in oocytes in contrast with the uterus, but in the oocytes themselves. However, it also allows reproductive biologists to go deeper in the understanding of aging processes, as shown by the increasing number of studies on the role of mitochondria in reproductive aging (e.g. Bentov and Casper 2013; Brenner et al. 2000; Dorland, van Kooij and Velde 1998; Keefe, Kumar and Kalmbach 2015; Pacella-Ince, Zander-Fox and Lan 2014) with the idea that by targeting aging itself, these cells could be made reproductive again. Therefore, it is through understanding the subtle interactions of the cellular components taking place inside the cell that the possibility of finely acting on these processes is opened up.

The transfer of ooplasm from young donor oocytes to old recipient's oocytes allowed reproductive biologists and clinicians to identify the importance of mitochondrial factors as key in oocyte aging processes. As mitochondria are located not only in reproductive cells, but also in all somatic cells, going thus beyond the strict reproductive environment, they contribute to a redefinition of reproductive aging understood as just aging. As a result, the traffic between reproductive and anti-aging sociotechnical projects has increased, as shown by studies where knowledge on somatic aging and reproductive aging cross and feed into each other (see for ex. Dorland, van Kooij and Velde 1998; Hanna et al. 2009; Kirkwood 1998).

4.4.3. A SIMPLE MATTER OF AGING?

To think further about the possible redefinition of reproductive aging as aging processes taking place at the cellular level, and about the importance of "quality", I want to focus on a recent issue

[64] Their functioning depends also on nuclear genes, see glossary (Appendix 1).

of the ASRM Journal *Fertility and Sterility* (2013). This issue presents five review articles, which examine several aspects of the effects of aging on fertility, including male infertility, and proposing new directions for research. The general trend of these articles illustrates very well the focus on oocyte quality and the tendency to reintroduce environmental factors into reproductive aging processes, that can be observed more generally in research on reproductive aging published since the 2000s (e.g. Gleicher, Weghofer and Barad 2011 on the role of DHEA; Kujjo and Perez 2012 on the role of mitochondria). I will focus on two of these articles (Bentov and Casper 2013; Tatone and Amicarelli 2013), as well as on the editorial of the issue (Meldrum 2013).

The first review article focuses on the central role of mitochondrial function and oocyte quality and calls for randomized trials to test it. Entitled "The aging oocyte – can mitochondrial function be improved?", the article by two Canada-based reproductive biologists Bentov and Casper (2013), explores possible causes of the age-related decrease in oocyte quality as highlighted by egg donation studies. The authors refer to the two competing explanations of reproductive aging, or rather in their terms, of "age-related decline in oocyte quality", already presented in Noyes' article, that is to say whether the loss of quality is due to a selection process starting with the highest quality oocytes and leaving the poorer ones for an older age according to the production line hypothesis, or to the aging process itself, affecting oocytes remaining in a fragile state of arrest for years. Drawing on results from studies on ooplasmic transfer between oocytes, and assuming that their beneficial effects are due to mitochondria present in the ooplasm, they suggest that "reproductive aging is not the result of a preferential selection of oocytes but rather the effect of the aging process and, more specifically, the aging effect on the function of the mitochondria" (Bentov and Casper 2013: 19). Therefore, the focus is on the aging process itself, which acquires its full meaning in relation to the temporality that makes oocytes stay in ovaries for years before being recruited for ovulation.

By trying to understand how the energetic metabolism of the cell is affected by aging, and how it might lead to a higher rate of chromosomal abnormalities, they identify directions for research and possible means of impacting on the very process of oocyte aging. Instead of proposing to act at the core of the cellular metabolism and functioning, they conclude by suggesting that a supplement in mitochondrial nutrients in the diet of older women should have a positive impact on pregnancy outcome by improving the function of mitochondria and thus the cellular energy production. These nutrients are "naturally occurring chemicals" such as CoQ10, an enzyme playing a role in the energetic metabolism of the cell, and r-alpha lipoid acid (ALA), which is a vitamin-like chemical, also commonly called an antioxidant because of its protective effect against

oxidative stress, known to be one of the key mechanism of aging (the free radical theory of aging was proposed by Harman 1992; Harman and others 1955). They are apparently safe for the mother and for the foetus as tested on animals. Both molecules can be found in dietary supplements on the more general market of anti-aging and health products. Therefore by trying to understand the aging process at the core of the functioning of the reproductive cells and the key role of mitochondria in the egg's quality, these authors end up by proposing that an external factor, an alimentary supplement, might have an impact on the reproductive competence of the oocyte and therefore on pregnancy outcome.

A similar movement can be observed in the second review article I would like to present. Entitled "The aging ovary – the poor granulosa cells", it is published by an Italian team based in Naples (Tatone and Amicarelli 2013). Starting from the free radical theory of aging proposed by the famous gerontologist Denham Harman (Harman 1972; Harman 1992; Harman and others 1955), which highlighted the central role of oxidative stress in aging processes, they try to identify the mechanisms leading to age-related molecular "damage" in the human ovary. Age-related oxidative stress is the inability of the cells to repair "damage" done by biochemical reactions. Focusing on cellular metabolism, these reproductive biologists investigate the possible age-related oxidative stress in granulosa cells, the cells surrounding the oocytes and producing the hormone FSH. As a consequence, ovarian aging becomes here defined as the "progressive and irreversible accumulation of damage to macromolecular integrity leading to loss of metabolic homeostasis and decrease of primary functions" (Tatone and Amicarelli 2013: 13). The authors end up by listing several elements potentially able to stop or slow down the aging of oocytes. Among others, they mention several molecules, but also dietary agents, medicinal plants such as green tea, and physical exercise.

The focus on external elements enabling patients to act on reproductive aging at a personal level in complement to biotechnical intervention is repeated in the conclusion of the editorial of the issue, entitled "Aging gonads, glands, and gametes: immutable or partially reversible changes?" by David Meldrum, a California-based reproductive doctor, when he writes:

> *The potential for improving the fertility and IVF success of our older couples is exciting. We will be able to partially turn back the clock for many of these patients, but the real value of the present review may be to emphasize that better life choices must be made throughout the period when a woman's oocytes are lying in waiting, and at the very latest as soon as she and her partner begin their efforts to conceive (Meldrum 2013: 3).*

This focus echoes the recommendations found on his website and intended for patients at risk of infertility or undergoing ARTs treatment[65]. There one can find a list of antioxidant aliments, a list of male and female fertility supplements, such as omega 3 fatty acids, folic acid, or co-enzyme Q10, as well as recommendations on overweight and physical exercise, not really different from any recommendations about healthy aging.

Without entering more into the details, these two studies and their editorial show how transfers between aging theories and reproductive biology lead scientists to try to understand the effects of aging on fertility at a molecular level. Reproductive aging hence becomes defined at the molecular level, both as a "progressive and irreversible process" (Tatone and Amicarelli 2013: 13) and as appealing to an external intervention – biotechnological (molecules) or related to lifestyle measures, as a way of preventing or hopefully slowing down these processes. The repetitive use of the term "damage" to describe changes in the aging cells illustrates well how aging is framed as a negative process that needs to be targeted and how at the same time an external intervention becomes necessary in order to "repair" the cell, which it is not able to do it by itself.

By locating age at the molecular level, the ontology of reproductive aging is transformed as it becomes a matter of general aging, not specific to reproduction. These researchers reopen the frontier between environmental factors and aging itself that egg donation programs had closed by showing that just by transferring young eggs into re-hormonally-normalized uterus, female fertility could be extended, independently from environmental factors and from an individual's will. Therefore molecular transfers generate a redefinition of reproductive aging as sensitive to external factors and to some extent to individual agency. Their work thus illustrates how the taking into account of environmental factors and the understanding of aging processes themselves are not opposed. Therefore the "molecularization" (Rose 2007) of ovarian age, instead of biologising the relation between age and fertility in an essentialist and fixed way, seems rather to prove how complex it is, and in need of a "multifaceted approach" (Meldrum 2013: 1).

Another economy of responsibility emerges as a result of the focus on aging processes and of the redefinition of reproductive aging as sensible to environmental factors. Adopting and consuming the right products, the right molecules and adopting a healthy lifestyle, seem to constitute an easy way of acting on reproductive aging. It therefore gives hope that simple action may make the process of aging less ineluctable and more reversible. However, it entails also that women become actively engaged in anticipating and taking care of their reproductive futures, even more

[65] See: http://www.lifechoicesandfertility.com - accessed on January 6, 2016.

than is already the case. These recommendations may put the responsibility of age-related infertility even more onto single individuals, rather than in relation to social conditions, or medical ones, and might also give a false impression that just by staying "young" – by exercising and consuming antioxidant aliments – women might be able to act on reproductive aging. This individualization echoes current debates on new forms of "biological citizenship" (Rose 2007) associated with egg freezing and resting also on the individual's responsibility to anticipate her own reproductive future (Adams, Murphy and Clarke 2009; Martin 2010).

Intermediary remarks

This chapter has highlighted the importance of the role of "transfer" in the emergence and making of "old eggs" and in the passage from age – chronological and statistical – to aging – biological processes of aging taking place inside the body. Transfers that have framed the making of ovarian aging can be observed at several levels. First of all, the transfer of knowledge and technique from non-human animals, especially rodents, to humans can be observed. Secondly, a transfer of younger oocytes to older recipients, enabling age to be localised in the eggs and making the oocytes identifiable as the primary site of reproductive aging. Thirdly, this logic of transfer can also be found in the transfer of ooplasm from younger oocytes to older oocytes in order to rejuvenate them or to increase their reproductive competence, allowing also the targeting of the site of aging more precisely and resulting in a redefinition of reproductive aging as aging processes at a molecular level. Finally, an ongoing and increasing traffic between research on general aging and on reproduction can be observed, whose numerous and complex ramifications still need to be studied, such as the role of "telomeres" in studies on somatic aging (Moreira 2015) and in human reproduction (Kalmbach et al. 2013).

The signature of these transfers is that they contribute to locate age by being reproductive, and that when they are reproductive, they work also to extend female fertility or have rejuvenating effects at the cellular level. They reflect thus the traffic between a clinical logic oriented towards the optimization of success rates – making older bodies reproductive – and a research logic aiming at understanding aging processes in order to be able to act on them. These transfers have effects on the definitions of reproductive aging in relation to its location, but they also have an effect on the emergence, confirmation, and targeting, of the oocyte's quality. Quality becomes a crucial element as it resists the scope of action of reproductive biotechnologies. It becomes the crucial dimension affected by aging and therefore the place in which to target intervention.

The focus on the oocyte's quality comes from a concern about the births of "defective children" and the role that age plays in defective oocytes. While egg donation programs associate the oocyte's quality and age, and confirm that the oocyte's quality matters as it prevents older bodies from becoming reproductive, ooplasmic transfer enables reproductive biologists to study more deeply what affects quality inside the cell, at a molecular level. It leads them to take into account external factors that might have an impact on reproductive aging, with the goal of improving oocyte reproductive capacity. As a result of the understanding of reproductive aging, as aging processes, the distinction between environment and aging itself is reopened, leading possibly to a new moral economy of responsibility where individual responsibility to anticipate the effect of aging on fertility is put to the fore.

While I have focused on the central element of oocyte quality in relation to the birth of "defective children", to pregnancy and to implantation rates, as well as to the *in vitro* development of fertilized oocytes, I propose that we now move to the complementary question of their quantity and to the controversy regarding the possibility of postnatal renewal of oocytes. If this chapter has documented how ART's and various transfers played a key role on the passage from age to aging and their ongoing tensions, the next one will show some of the stakes of focusing on reproductive aging itself.

5. "Eggs for ever"?[66] The promise of oocyte (re)generation

I had been in the world of reproductive medicine for a few months, when, in February 2012, I read newspaper and online article headlines stating that a "Study claims 'unlimited eggs' possible" (Hastings 2012); "Ovary stem cells can produce new human eggs, scientists say" (Park 2012); "Egg-making stem cells found in adult ovaries: discovery could pave the way for new fertility treatments and a longer reproductive life" (Powell 2012); and "What if women could produce oocytes their whole life", followed by the subtitle "Fascinating. According to a study, to create oocytes without age limits will be possible soon"[67] (Anonymous 2012). Illustrating the latter title, there was a black and white photograph of two old ladies, dressed in an old-fashioned way and wearing hats and glasses. They were shown knitting on a bench, with a small blond child sitting between and slightly behind them. The women looked really old and it seemed obvious, from a common sense perspective, that the child was not their own, creating thus a kind of humorous distance with the title that promised a new future for motherhood. Embedded in the language of potentiality (Taussig, Hoeyer and Helmreich 2013), these headlines and the picture indicated how the prospect of acting biotechnologically on reproductive aging raised imaginary futures where postmenopausal mothers might become the new normal, but also might not, as the gap between a biotechnologically driven future promising lifelong fertility and the reality of daily life seems too broad.

The idea that oocytes might be renewed postnatally was at odds with the few things that I had learned about the biology of reproduction since the beginning of my fieldwork. Indeed I had spent enough time in reproductive medicine to realize how strongly organized it was around the core idea that women are born with a limited pool of oocytes which decline steadily and irreversibly in quantity and quality with aging. Many aspects of "the question of age", such as the age limits to egg donation, freezing and late motherhood, or the reasons leading to the postponement of childbirth and its consequences in medical terms, could be discussed with the Swiss experts I met. However one idea remained unquestioned and provided the entrenched grounding of our discussions: that fertility declines as a consequence of the aging of the reproductive system which takes place much earlier than other organs, that it is a natural specificity of the female reproductive systems, in opposition to the males', and part of a "natural" and "universal" order structuring gender and intergenerational relations. Moreover, it provided an explanation for the lack of success of IVF in older women and was consequently constituted as

[66] Title of an article critical of Tilly and colleague's work (Byskov et al. 2005) and used in Tilly's response (Skaznik-Wikiel et al. 2007).
[67] Translated by the author.

an obstacle to its working, especially in the Swiss context where the use of donated eggs is legally prohibited.

Intrigued by these newspapers headlines, and by the contrast I observed between these two versions of age-related infertility, I had a closer look at the original article they were commenting on. Entitled "Oocyte formation by mitotically active germ cells purified from ovaries of reproductive-age women" (White et al. 2012) and published in the renown scientific journal *Nature Medicine*, the article describes first the development of an isolation protocol enabling the identification and collection of germline or oogonial stem cells (GSCs or OSCs) from adult mice ovaries. It then explains how this protocol has been used to isolate similar cells from the ovarian cortical tissue of six women aged between 22 and 33 who were undergoing sex reassignment surgery. Finally, it reports how these cells have been tested *in vitro* (in culture) and *in vivo* (through transplantation (grafting) of fragments of human ovarian tissue injected with traceable OSCs under the skin of mice) in order to examine whether they developed into oocyte-like cells[68], which proved to be the case. Even though these cells had not been fertilized and the question of knowing whether they could develop into a healthy baby was still unanswered, this study was deemed revolutionary in the sense that it isolated cells whose existence was totally unsuspected a decade earlier.

The contrast between what I knew from reproductive medicine and biology in Switzerland and this line of scientific inquiry struck me. How could two versions of reproductive aging, that were so different, coexist? How could reproductive aging be a universal and irreversible process of ovarian depletion in reproductive medicine and science and be a reversible process in some other basic research findings? How could the ovary be endowed with a limited and non-renewable pool of oocytes before birth and be an ongoing producer of oocytes in adult life? Echoing my questions, I discovered that the putative existence of these cells had been the object of fierce scientific controversy ever since the American reproductive biologist Jonathan Tilly and his team published an article, eight years earlier, reporting that germline stem cells (GSCs) had been identified in mice ovaries, opening up the possibility of a follicular renewal in adult mammals (Johnson et al. 2004).

This moment of my fieldwork is significant because it reveals that the taken-for-granted nature of reproductive aging is perhaps less stable than might have been expected. Not only can fertility be

[68] Tilly defines "oocyte- like cells" as "reflecting their many similarities to oocytes, including their ability to form hormonally active, gonadotropin-responsive follicles, while at the same time acknowledging their inability to complete meiosis" (Tilly, Niikura, Rueda 2009: 9).

medically extended by a substitution process such as in egg donation, but also the biology of aging ovaries itself might be more flexible and open to biotechnological reengineering than what is usually thought possible. Of course, this could be another cycle of biotechnological hype leading to disappointment (Brown 2003) as it appeared to a Swiss sceptical reproductive biologist I tackled the topic with (Dr. H. 20.02. and 30.04. 2012). Of course, this could be another seriously flawed experiment as had already occurred in the field of stem cell research (Thompson 2013). However, whatever the status of truth or the reality of these oogonial stem cells, the publication of the article by White et al. (2012) and the controversy that preceded it are important to examine, as they give insight into the contested nature of reproductive aging and the promissory work necessary to challenge what is called the "dogma" in the field of reproductive biology, which assumes that the oocyte production, or oogenesis, in female mammal ovaries ceases after birth, in contrast to male spermatogenesis, and non-mammalian vertebrates (Gosden 2004; Johnson et al. 2004).

In the previous chapters, I documented firstly the efforts of demographers and epidemiologists to isolate the effects of "age alone" on fertility, and secondly the emergence of the notion of ovarian aging or "old eggs". Both chapters have highlighted the crucial role played by ARTs in the production of knowledge about the relations between age and reproduction. They both have especially shown the ongoing tension between age as a statistical and chronological measure and aging as the biological – cellular, biochemical, molecular – processes taking place inside the body, and even at a smaller scale, in the cells. While the tension persists, and chronological age constitutes a condition of possibility for reproductive aging to exist, the latter gains also an increasing independence, as it becomes an object of study in itself. This chapter goes on with the exploration of the traffic between reproductive and anti-aging or regenerative sociotechnical projects. It goes a step further by focusing especially on what happens to ovarian aging when it becomes the main object of study of reproductive biologists and the target of both scientific inquiry and possible future medical intervention.

5.1. What a controversy opens up

Social scientists have analysed the multiple reconfigurations of "life" occurring in bioscience, biomedicine and biotechnologies, and have questioned the effects of these reconfigurations on categories, relations, and subjectivities, based on a notion of "life" as pre-existing and fixed (e.g. Franklin 2003; Franklin 2007; Franklin and Lock 2001; Helmreich 2003; Hird 2004; Rose 2007; Squier 2004). Drawing on this literature, I aim to explore how reproductive aging is transformed

when it becomes the target of anti-aging or regenerative intervention. The questions I ask are what kind of work is performed by scientists, that following Konrad we can call "ova cultivation pioneers" (2005: 15), in order to create an alternative version of ovarian aging? And how does the promise of regenerating eggs and therefore of "eggs for ever", transform the nature of ovarian aging?

To do so, I explore the controversy that took place between the publication of the initial article stating that putative germline stem cells in mice had been identified (Johnson et al. 2004) and the publication, eight years later, of the article by White et al. (2012), claiming that such cells have been identified, isolated, and cultured, from human ovaries, and are able of generating oocytes. By following the controversy, I will show how the promise of the existence of these cells and of their possible use in the clinic is performed and contested. I will also show how this controversy results from and reflects what is at stake in the traffic between the anti-aging, or regenerative, and the reproductive sociotechnical projects and how the ontological status of ovarian aging is challenged when it becomes the target of regenerative science. While the controversy over the capacity of ovaries to produce new oocytes in mammalian adult life and the existence of oogonial stem cells is ongoing (Evron and Blumenfeld 2013; Zhang et al. 2013), I decided to take 2012 as the endpoint of my examination. The reason is that it marks a tilting point in the controversy's actors positioning because two of the most vocal critical voices of Tilly and colleagues' work – Telfer from the Institute of Cell Biology in Edinburgh and Albertini from the Department of Anatomy and Cellular Biology in Boston – changed sides and started collaborating with him, one on the board of his company *Ovascience*[69], and the other in direct teamwork by providing expertise on the *in vitro* development of human oocyte (Gura 2012).

One can ask why it is interesting to examine this controversy. The first reason is that it gives a privileged insight into the contested scientific definitions and understandings of reproductive aging. While a certain version of reproductive aging, as an irreversible decrease in oocyte quality and quantity, organizes practices in the clinic and frames women's experiences of infertility, it has also framed scientific research in reproductive biology since the 1950s and the establishment of the "dogma" by the English zoologist and anatomist Zuckerman (Mandl and Zuckerman 1951; Zuckerman 1951). Yet, since 2004, this version has been much debated in the field and proven to be much less stable than usually thought. Therefore it is interesting to look at this controversy in order to understand how the "nature" of reproductive aging itself becomes contested and what are the implications of its different versions. This proves to be even more relevant, as the current

[69] See the website: http://www.ovascience.com/ - accessed on December 15, 2015.

controversy can be read as the reopening of an older controversy that took place during the first half of the twentieth century, showing that the nature of reproductive aging has probably never been as stable as it seemed (e.g. Allen 1923; Arai 1920; Evans and Swezy 1932; Simkins 1932; Swezy and Evans 1930).

The second reason is that while future-oriented and embedded in the language of potentiality, the clinical possible impacts of these basic research findings stand always in the background of these studies and of the debates surrounding them. Tomorrow's clinical practices might be today's science (Woods and Tilly 2012), but also might never be, and having a look at what is at stake in this controversy helps us to understand how reproductive aging becomes a key site in the growing and expanding platform of ARTs, stem cells, and regenerative medicine (Franklin 2013a) where promissory work performed by scientists reveals itself as crucial. This can be seen in scientific research, but also at the level of the clinic, in the creation of the company called *Ovascience* by Jonathan Tilly in 2011 (Gura 2012) where the promise of using what is there called "egg precursor cells" (EggPC^{SM}) materializes in clinical applications targeting older women, and especially in important financial value as the company has "secured US$48 millions in venture capital" (Gura 2012: 320).

The third reason for why it is important to examine this controversy is that it allows a focus on the flip side of quality, which is quantity. We have seen in the last chapter how the idea of the quality of oocytes has become central, among others, through the important role played by egg donation programs in the production of knowledge on reproductive aging. We have seen how by trying to understand what affects the quality of oocytes, we had to enter into the cell itself, which paradoxically brought us back to the taking into account of environmental factors likely to damage oocytes produced before birth and then arrested in a fragile state of meiotic division, and resting in the ovaries for years. However, in parallel, the question of the age-related decrease in oocyte quantity has never really left the stage, and as we will see, has taken the shape of a possible post-natal renewal of oocytes.

This chapter is divided into four sections. The first one documents the technical work necessary to make OSCs exist, by presenting the two studies that launched the controversy in the field of reproductive biology (Jonhson et al. 2004; Johnson et al. 2005). The second section provides an overview of the main points and key moments of the controversy. The third section focuses on cells ontologies. It shows how the controversy's core is about the putative existence of OSCs and highlights how their status is negotiated and transformed. Finally, the fourth section focuses on

the promissory work performed by reproductive biologists defending the idea of a postnatal oocyte renewal, and necessary to the production of an alternative version of reproductive aging.

5.2. Challenging the dogma

In 2004, the reproductive biologist Jonathan Tilly and his colleagues from the Vincent Centre for Reproductive Biology in the Massachusetts General Hospital and the Harvard Medical School in Boston, published an article in the renowned scientific journal *Nature* (Johnson et al. 2004). This article initiated many debates by challenging the "central dogma of mammalian reproductive biology" that assumes that mammals are born with a non-renewable oocyte pool declining with age. Entitled "Germline stem cells and follicular renewal in the postnatal mammalian ovary" the article presents the results of experiments on mice showing that their ovaries contain germline stem cells that might be able to replenish the pool of follicles in adult life, in a way similar to the ongoing production of sperm.

5.2.1. UNDERSTANDING CELL DEATH

To understand Tilly and his team's goal, it is important to say a few words about what is generally assumed about the dynamics of oocytes contained in follicles and to go back to Tilly's previous work. Women's, and more generally mammals', ovaries are thought to be endowed before birth with a limited pool of primordial follicles containing oocytes, the germ cells of the ovaries, arrested in a first and fragile phase of cellular division specific to gametes that is called meiosis. This pool of primordial follicles formed in foetal life declines through various mechanisms, notably programmed cell death by atresia, called apoptosis[70], and since puberty, ovulation. This depletion process already starts prenatally and goes on during childhood, making an approximate initial number of 1-2 million oocytes containing primordial follicles reduce to 300 000 when reaching puberty (Tilly 2001; Woodruff 2008), until they reach exhaustion. Their number plays a key role in reproductive aging as it is a trigger for the menopause when the pool is below a threshold of about 1000 (Faddy et al. 1992). In addition, during each menstrual cycle, 4 to 10 primordial follicles grow and mature, passing through different stages, but just one will finally be ovulated, while the other ones degenerate and are reabsorbed (Powell 2007b).

[70] Apoptosis designates the process of genetically « programmed cell death », that is not pathological. It was initially described by Walter Flemming in 1885 based on the observation of cellular degeneration in the rabbit ovary (Clarke et Clarke 1996; Flemming 1885; Tilly 2001). Almost a century later, a paper generally referred to as a landmark in the study of cell death, uses the term "apoptosis" for the first time (Kerr, Wyllie and Currie 1972). For further study see Tapanainen (2002) and Clarke and Clarke (1996).

Therefore an important question that reproductive biologists try to answer is "how and why the female body creates, only to delete, so many germ cells" (Tilly 2001: 838). In other words, why are the ovaries of the female foetus endowed with such a high number of follicles during gestation, only to "waste" them during reproductive life? Why is there no renewal in adult life, such as in sperm production? In the 1990s, Tilly and his colleagues tried to answer these questions. The idea underlying their work is that by understanding the cellular, genetic, and molecular processes causing cell death in ovaries, it would be possible to find a way of controlling it, slowing it down or even stopping it (e.g. Morita and Tilly 1999; Perez et al. 1999; Pru and Tilly 2001; Tilly 1996). In a 2001 review article, entitled "Commuting the death sentence: how oocytes strive to survive" (Tilly 2001), Tilly presents the stakes of understanding cell death in ovaries. What is crucial for him is to test *in vivo* conclusions of studies realized so far mainly *in vitro* in cell-culture systems[71]. For him the ovary provides "a powerful model" in order to reach this goal and study the functionality of apoptosis. In this way, he inscribes himself in the aftermath of previous studies using egg donation programs or ooplasmic transfer as "*in vivo* model", which enabled the understanding of the importance of mitochondrial factors in reproductive aging as shown in the previous chapter.

Characteristic of his work, as of much work done on reproductive aging, is the joining of the anti-aging and reproductive sociotechnical projects, as can be read in the following quotation:

> *Assuming that other steps in the oocyte death programme are similarly conserved, there is the prospect that promising new therapies could be used to prolong the natural lifespan of the ovaries. As such, perhaps strategies that are developed to combat premature menopause will also be useful "anti-ageing" agents in women, to alleviate the postmenopausal health problems that are attributed to ovarian senescence (Pru and Tilly 2001: 846).*

The understanding of cell death cellular and molecular mechanisms in ovaries may open up new possibilities of "controlling" reproductive aging and extending fertility, but by doing so, the extension of fertility could also work as anti-aging, by having an impact on other symptoms associated with the end of fertility, namely the menopause. In other words, anti-aging science aiming to understand apoptosis targets ovarian aging as a model, that is, it uses reproduction to produce knowledge about aging. By doing so, older bodies might be made reproductive by the prolongation of the "natural lifespan of ovaries" and rejuvenated at the same time by the alleviation of postmenopausal health problems. This aspect of Tilly's work makes it a crucial site

[71] For a history of cell culture, see Landecker 2007.

for understanding how extending fertility and preventing age-related health problems become one common goal, or in other words how fertility becomes a question of aging. These elements provide the background to the path-breaking results of 2004 and help us to understand the degree to which it has challenged the dogma of the limited pool and the reason why Tilly decided to dedicate his work to the search for oogonial stem cells (Powell 2007b).

5.2.2. DISCORDANT COUNTINGS

Even though fairly recent, the "discovery" of Tilly and his team has already been narrated in an epic way (Powell 2007b). As an example let us listen to the description of the science writer Kendall Powell, who followed and covered most of Tilly's works and related debates (Powell 2004; Powell 2005; Powell 2006; Powell 2007a; Powell 2007b; Powell 2012):

> *The data that would change the course of Jonathan Tilly's career and cause an uproar in the field of ovarian biology almost never saw the light of day. In Tilly's cell death lab, postdoctoral fellow Tomoko Kaneko had twice repeated her experiments to kill off mouse egg cells, but something was wrong because the egg cell numbers were still high after treatment with a chemotherapy drug. Kaneko consulted another postdoc in the lab, Josh Johnson, and together they tried to determine if she had made a technical mistake or perhaps switched her control and experimental groups. "All of us "knew" that egg regeneration couldn't be occurring," says Johnson, referring to the long-held view that adult female mammals are born with a fixed pool of oocytes, or egg cells, which gradually declines in number with age. The work appeared to be an anomaly, but Johnson prodded Kaneko to take it to their advisor's office. That 2002 meeting was the birth of an ongoing controversy that has shaken up the field of reproductive biology, with Tilly's laboratory publishing data they interpret as evidence of egg regeneration occurring in adult mice (Powell 2007b: 2748).*

If we follow Powell's narrative, everything started with a routine counting of oocytes resulting in an unexpected high number, performed by a postdoctoral fellow in Tilly's laboratory, and going against what was generally taken for granted in the field. As we can read in this excerpt, Tilly and his co-workers, are represented as making a revolutionary discovery by serendipity out of routine work. Narrated in scientific terms, a parallel story is told in the article by Johnson et al. (2004) presenting the first observations leading to their challenging results. They were initially conducted in the framework of Tilly's working on cell death in ovaries, in a study aimed at assessing the number of healthy follicles (non-atretic) from the degenerating (atretic) follicles in a specific strain of mouse, the C57BL/6 mouse.

Two crucial observations on the rate of atresia of the immature follicle pool were made, once by counting them at specific days of mice's lives, and the second time by administering a chemical product (DMBA) to mice, inducing the degeneration of immature oocytes. According to the rate of depletion the reproductive biologists could observe, they deduced statistically that the follicles reserve would be exhausted by young adulthood, which was incongruous with the number of healthy follicles they could identify, leading them to highlight "a clear discordance between changes in non-atretic [healthy] follicle numbers and the corresponding incidence of atresia in the postnatal mammalian ovary" (Johnson et al. 2004: 146). These two initial observations lead Tilly and coworkers to postulate that there must be a renewal or replenishment process of oocytes taking place in the ovaries and explaining that ovaries are not depleted earlier.

This initial hypothesis was put to the test in different experiments using several techniques with the goal of identifying these possible cells and understanding their function. The first experiment is based on the gold standard method in the field of ovarian aging since the beginning of the twentieth century, that is ovarian histology and follicle counts called also an histo-morphometric approach (Skaznik-Wikiel et al. 2007). It consists mainly in counting the different kinds of follicles containing oocytes present in slices of ovaries, fixed, stained, and studied with a microscope. What is at stake is to differentiate the different kinds of follicles and to identify those that are really atretic, according to specific criteria – in this study convoluted, condensed, or fragmented. The histological analysis – which is the study of the microscopic anatomy of cells and tissues – of mice ovaries at different ages, enabled the scientists to identify "large ovoid cells, resembling germ cells of fetal mouse ovaries, in the surface epithelial cell layer covering the ovary" (Johnson et al. 2004: 146). This means that they found a specific kind of cells that did not fit into their categories of follicles, leading them to assume that these cells might be oogonial germ cells, the stem cell of the ovaries.

To ascertain that these large ovoid cells, identified according to morphological criteria, were the germ cells they were looking for, they turned to another range of techniques in immunohistochemistry. These techniques aim to detect proteins or specific gene expression in cells or tissue sections by using immunological reactions. They used these markers to verify that the cells they identified proliferate and undergo meiosis, a process of cellular division necessary to produce an oocyte. Relying on highly sophisticated methods of identification and localisation, what is at stake is the characterization of these cells as having the properties – specific genes, ability to proliferate and initiate meiosis – of germ cells, properties that should not be found in other follicles, or other tissues.

To go further in the study of the possible renewal of follicles, scientists injected mice with a cytotoxic product, busulphan, targeting especially germline stem cells, two times, and then retrieved their ovaries to count primordial follicles and assess whether there was any change, in comparison with a group of control mice. Comparing their results with previous results on follicle numbers and dynamics in mice (Faddy, Telfer and Gosden 1987), they observed a difference between the supposed number of degenerating follicles and the number they actually observed, which made them conclude that there is a primordial follicle renewal during a certain period of time. Here what is at stake is not only to prove the presence of possible germline stem cells, but to show that they contribute quantitatively to a renewal in primordial follicles. Therefore, the presence of a renewal process is established by a differential in numbers based on statistical models and calculation of rates of depletion.

For the final experiment, the scientists grafted fragments of ovaries taken from regular mice – wild-type – and grafted them into the ovarian cavity of transgenic mice, with the specificity of having a protein, the green fluorescent protein (GFP), which displays green fluorescence when observed with a certain kind of light. When they removed these ovaries, they were able to observe the expression of the protein in the ovarian grafts, suggesting that the germ cells of the transgenic mice had infiltrated the grafted tissue and started to proliferate, and create new follicles. These cells were then analysed histomorphologically and counted. This final experiment is used not only to attest the presence of germline stem cells, but to show that they function and initiate the production of new follicles in adult mice.

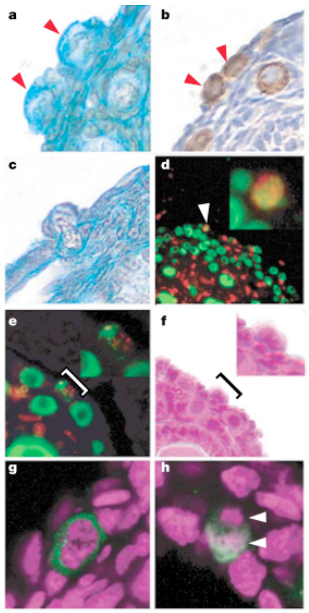


Figure 2 Germ-cell proliferation in juvenile and young adult ovaries. **a**, Presumptive GSCs (arrowheads) in the surface epithelium. **b**, Immunohistochemical detection of MVH (brown reaction product) in presumptive GSCs (arrowheads). **c**, Presumptive GSC undergoing mitosis across the surface epithelium. **d**, **e**, Dual immunostaining for BrdU (red) and MVH (green) in juvenile and young adult mouse ovaries. **f**, Haematoxylin and eosin staining of the section shown in **e**, highlighting the dividing germ cell. **g**, **h**, Chromatin morphology (propidium iodide counterstaining, violet) within MVH-positive cells (green) shows a germ cell in prometaphase (**g**) and a germ cell in metaphase (**h**; sister chromatids highlighted by arrowheads).

Source: Johnson et al. (2004). Illustrates the presumptive germ stem cells identified by Tilly and his team in 2004.

Based on the junction of the results of these various experiments, the authors concluded that their study challenged the "dogma" by showing the presence of functioning germ cells in adult mice, and that "the data shown also underscore the significance of mammalian female GSCs to regenerating the follicle reserve in adult life", which "has significant clinical implications related to therapeutic expansion of the follicle reserve as a means to postpone normal or premature ovarian failure" (Johnson et al. 2004: 149). However, many questions remained open, especially concerning the origin of these cells, their properties and their function in the physiology of mammal ovaries (Greenfeld and Flaws 2004).

Extending their initial research and complementing their original hypotheses, Tilly and his colleagues answered partially these questions and specifically the question of the origin of GSCs, one year later, in the prestigious scientific journal *Cell* (Johnson et al. 2005a). They reported that they had identified germline markers in bone marrow and that when transplanted into sterile mice it restored oocyte production, leading them to assume that "bone marrow is a potential source of germ cells that could sustain oocyte production in adulthood" (Johnson et al. 2005a: 303). Not only challenging the idea of a prenatally fixed pool of oocytes as in their first study, in the second one, the geography of oogenesis itself was troubled, as it implied that oocytes could have an origin outside the ovaries. These two papers initiated a controversy that has shaken up the field of reproductive biology by challenging the basic ideas on which research had been done during more than fifty years.

5.3. Neo-oogenesis, "a fantasy or a reality"[72]?

The articles by Tilly and colleagues were presented in the media with much publicity and in a highly optimistic tone regarding possible clinical applications (Powell 2007b). In contrast to the public enthusiasm and hopes generated by these discoveries, in scientific circles the first article caused immediate controversy, followed by a second wave of critics around the publication of the second article. The difference between the two papers regarding the origin of the putative oogonial stem cells, seen as a prolongation and follow-up work supporting their initial hypothesis by Tilly and colleagues (Johnson et al. 2005b), increased the suspicion of the first results, as can be read in the following quotation by Albertini: "There are so many inconsistencies between the first paper and this one, it makes it very difficult to believe in these findings" (quoted in Powell 2005: 911).

[72] Inspired by the title of the article by Gougeon (2005).

5.3.1. FROM SCEPTICISM TO MEASURED ENTHUSIASM

Critics of Tilly's work display various degrees of scepticism ranging from radical disbelief (Gosden 2004; Powell 2006; Telfer et al. 2005) to cautiousness (Gougeon 2005; Hoyer 2004), including subtle elaboration of alternative interpretations of the initial results and production of complementary data (Byskov et al. 2005; Greenfeld and Flaws 2004). Meanwhile Tilly and his colleagues answered the critiques and discussed the alternative interpretations of their opponents, whilst additional original studies supporting in turn the arguments of one side and the other were published. At the core of the controversy was the validity of the so-called dogma of a fixed pool of oocytes grounding all the research done in the field since the fifties, to the point that the controversy took the shape of a schism between supporters of the "fixed-pool model" and supporters of the "stem cell model" (Hutt and Albertini 2006), the latter challenging the former.

The question of knowing whether women are born with a fixed pool of oocytes declining with aging, or if there might be a renewal of oocytes during adult life might seem insignificant since oocytes end up reaching exhaustion anyway and the human menopause, occurring in the middle of women's chronological lifespan, seems to be a universal phenomenon (Byskov et al. 2005; Greenfeld and Flaws 2004; Tilly and Telfer 2009). However, to identify and understand the underlying causes and mechanisms of follicular depletion opens up the prospect of being able to target ovarian aging processes and consequently to postpone ovarian failure and prevent health problems associated with aging, which can have huge implications at the level of the clinic. This aspect is recognized by all participants in the controversy and the revolutionary aspect of Tilly's work is even highlighted by one of his opponents, who compared it to the "breakthrough in nuclear transfer" in the field of reproductive cloning (Gosden 2004). Tilly stresses this revolutionary aspect as well by comparing it to "what the neuroscience field experienced in the late 1990s, when claims of neurogenesis in the neocortex of adult primates first surfaced to challenge the century-old assumption that new neurons are produced in the adult mammalian brain" (Tilly, Niikura and Rueda 2009: 9). The importance of the issues at stake explains the shock wave that shook the field, but also why, in spite of the critics, most of them agree that Tilly's provocative work was beneficial for the whole field, as it questioned taken-for-granted assumptions and generated new lines of research and original studies, as one can read in the following quotation by an author, a critic of Tilly and colleagues' work: "Reproductive science and medicine have been strengthened by virtue of the discussion and are now poised to move to the next frontier" (Woodruff 2008: 1191), (see also Albertini 2004; Gosden 2004; Greenfeld and Flaws 2004; Telfer 2004).

Indeed, several important studies were published in the years following the publications of Johnson et al., the controversy taking the shape of a dialectical play of experiments and counter-experiment. First, Byskov et al. (2005) reexamined the data on the counting of follicles and reached alternative conclusions going against Tilly's findings. Then Eggan et al. (2006) addressed the bone marrow hypothesis and did not find any evidence of ovulation derived from bone marrow, leading Albertini to say that: "it incontestably shows that the Tilly work was simply not true" (quoted in Powell 2006: 795). The same year, Kerr et al. (2006) reproduced the experiment on counting follicles in the same strain of mice as the one Tilly and colleagues used, and observed that the follicle number remained relatively constant, providing "qualified support for an as yet unknown mechanism for follicle renewal" (Kerr et al. 2006: 107). However, another team (Bristol-Gould et al. 2006) provided data fully supporting the dogma by showing that "only the fixed pool model accurately reflected the observed gradual depletion of follicle numbers over time" (Hutt and Albertini 2006: 6).

The experiment-counter-experiment dialectic went on in 2007 and 2008, when Veitia et al. (2007) provided evidence against the hypothesis that the transplant of bone marrow might help to replenish the ovarian supply, along with Liu et al. (2007) who "demonstrate that adult human ovaries do not express specific genes crucial for meiosis, in contrast to early foetal ovaries" (Liu et al. 2007: 118), making it very unlikely that meiosis occurs in adult human ovaries. In 2008, Begum, Papaioannou and Gosden (2008) confirmed that there is no renewal. To do so, they used ovarian transplantation in a mouse model to test whether the pool of oocytes might be replenished by an extra-ovarian source. In contrast, Lee et al. (2007) identified "cells with germline potential in bone marrow of adult mammals" even though they did not mature for ovulation. These results were extended by the work of Virant-Klun et al. (2008) claiming to have found "adult OSCs with the expression of embryonic stem cell markers" (Virant-Klun et al. 2008: 843) from the ovaries of women.

The year 2009 marks a turning point in the controversy when Zou and colleagues from the School of Life Science and Biotechnology in Shanghai, China, published results claiming that they had identified and isolated a line of what they called female germline stem cells (FGSCs) from mice ovaries, which once grafted onto mice, were able to mature into oocytes and produce offspring (Zou et al. 2009). The production of offspring is the ultimate proof of the existence of these cells and had an important impact on the positioning of the actors in the controversy, as once can read in the following quote by Telfer: "The breakthrough for me in my relationship with Tilly was when the Chinese group published their paper in 2009", "convert[ing] her [to] the

dogma-breaking minority" (quoted in Connor 2012). Following this study Tilly and Telfer, his opponent since the beginning of the controversy, published an article together reviewing the debates and examining critically Zou et al.'s results (Tilly and Telfer 2009). This moment is critical because the idea of the coexistence of the two views is advanced for the first time by Tilly and Telfer when they write:

> *Although this debate has since been perceived as representing two clearly opposing viewpoints with common ground, the existence of GSC in mammalian ovaries is not necessarily inconsistent with the idea that females are born with all of the oocytes they will ever have. Indeed there is the possibility that both views can co-exist, with the formation of a fixed population of oocytes at birth that is normally not subject to renewal and the existence of GSC in adult ovaries that can only be activated under specific circumstances (Tilly and Telfer 2009: 394).*

The study by White et al. (2012) presented in the introduction of this chapter extended the results of Zou et al. (2009) by improving the protocol that enables the identification and isolation of OSCs and by isolating them for the first time in humans. These results, while not marking the end of the controversy, represented a turning point as Telfer and Albertini, both very critical of Tilly's work, changed sides. In an article published together and commenting on White et al. (2012)'s experiments, they write that it "represents a major breakthrough in identifying cells with apparent germline potential in both mouse and human ovary" (Telfer and Albertini 2012: 354) and "an advance that has the potential to change the nature of future fertility treatments" (Telfer and Albertini 2012: 354) that will "change the tone of future discourse on the subject toward measured enthusiasm and, most importantly, will prompt speculation and tempered progress into what remains a major obstacle in the treatment of various forms of human fertility" (Telfer and Albertini 2012: 354). Going even beyond a measured enthusiasm, they started collaborating closely with Tilly (Gura 2012).

5.3.2. PROBLEMATIC TRANSFERS

While the controversy focuses mainly on technical and methodological aspects enabling the proof or denial of the existence of these oogonial stem cells, other points are also debated, ranging from reproducibility of the results to communication issues. Roughly, the results produced by Tilly and his team are considered as flawed, lacking in evidence, the consequence of misinterpretation and miscalculation of the data (Albertini 2004; Gosden 2004; Greenfeld and Flaws 2004) and revealing "a curious piece of circular arithmetical reasoning" (Byskov et al. 2005:

442). The lack of reproducibility of the results, in the counting, and in the identification of gene markers characterizing germline stem cells are pointed out as additional evidence of the lack of validity of the work done (Albertini 2004; Byskov et al. 2005; Gosden 2004; Telfer et al. 2005).

The transferability or the "transposition" (Friese and Clarke 2012) of results from one strain of mice to another (Byskov et al. 2005; Gosden 2004), as well as from mice to human (Abban and Johnson 2009; Goldberg 2005; Hutt and Albertini 2006) is also discussed. Especially the question of the transfer from *in vitro* to *in vivo* experimental settings, and more generally from basic research to the clinic remains in the background of the debates (Powell 2007b; Woods and Tilly 2012). In this regard a critical point concerns the communication surrounding the publication of the results, as Tilly's overenthusiastic mode of communicating is at risk of generating false hopes and disappointment (Powell 2007b).

5.4. Cells ontologies

At the core of the controversy is the ontological status of ovarian aging. This can be observed at two different levels. Firstly, the ontology of germline or oogonial stem cells is a point of contention, in the sense that their existence itself is not proven and constitutes the main object of debate. Secondly, at a more general level, the putative existence of these cells has the power of redefining ovarian aging's ontological status. Through the controversy, not only the existence of cells themselves is discussed, but also the fixed-pool model that precludes the possibility of any renewal during adult life. As one entails the other, the redefinition of ovarian aging passes through the discussions of cells ontologies, the cell becoming the relevant unit of study and gaining an increased visibility. For this reason, the next section is dedicated to the various cells ontologies at stake in the controversy.

5.4.1. When common sense, scientific, and historical evidence conflate

The putative existence of the germline stem cells themselves, in regards to their origin, characteristics and function, is much debated (see for ex. Greenfeld and Flaws 2004). How could they remain unnoticed for so many years? How could they be missed? And how could they exist while the menopause still occurs at midlife? Underlying these debates, the evidence supporting the fixed-pool and the renewal models are at stake, pushing reproductive biologists to bring to the forefront and to make explicit the evidence supporting their claims and the ways in which they are produced.

First of all, Tilly's work goes against the common sense idea of the end of fertility at menopause as a universal event structuring women's reproductive lives, expressed by Gosden, a reproductive biologist whose work focuses on the dynamics of follicular depletion assessed through mathematical model and ovarian aging, and who is a vocal disputant of Tilly's work:

> *Whether or not the old theory is correct, we are confronted with the indubitable facts that oocyte quality and follicle numbers decline with age, signaling the end of the reproductive lifespan (Gosden 2004: 195).*

The apparent obviousness and common sense of the universality of the menopause constitute in fact an argument against the existence of the GSC, in the sense that even if they exist, they do not prevent ovaries from reaching exhaustion. This is echoed by Greenfeld and Flaws (2004) in their critical examination of Johnson et al. (2004)'s initial paper:

> *Perhaps the most important question to arise from the results of Johnson et al. is related to why reproductive senescence (menopause) occurs if GSCs are present in the ovary. Johnson et al. suggest that the potential for GSCs and follicular renewal exists, but this seems contrary to data indicating that mammalian ovaries gradually lose follicles with age, and that aged animals become infertile (Greenfeld and Flaws 2004: 831).*

The putative existence of GSC is very difficult to integrate into the common sense knowledge that fertility ends at the menopause. This first level of evidence is hard to combine with the idea of a possible renewal, as one can read in the conclusion of a paper signed by Telfer and 14 other colleagues, all experts in the field:

> *Moreover we are concerned that their hypothesis* [Tilly's] *is less reconcilable with pure reason and human biology than conventional theory. A finite stock of oocytes formed early in life still seems to better account for our current understanding of ovarian physiology (Telfer et al. 2005: 822).*

One consequence of Tilly's work is as one can see in the above quotations, a calling into question of the definition of ovarian aging and of its underlying mechanisms defying both common sense, "pure reason" and scientific knowledge, "understanding of ovarian physiology", both reinforcing each other. The presumed incoherence of Tilly's findings with the sense of the universality of the menopause is recurrent in the debates and leads scientists to discuss the status, definition and characteristics of the stem cells themselves, as one can read in an excerpt of the critical commentary by Byskov et al. (2005):

> *The classical definition of stem cells is that they perpetually renew themselves and generate differentiated progeny, which in the ovary will be the oocytes. Thus, if the follicle population is being replenished continuously during adult life, as claimed, GSCs must progressively lose their ability to multiply to account for declining fecundity. Such an aging behavior has been considered exceptional among stem cells, although stem cells may suffer from age-related functional deletions which could possibly explain aging. There can be no doubt that the human menopause is universal (Byskov et al. 2005: 438).*

The focus on GSCs and their (im)possible aging leads in return to a redefinition of ovarian aging, as shown in the answer by Johnson et al. (2005b) to these critiques. In opposition to the idea that stem cells do not age, they assert that they do age and that it is exactly this process that would explain the end of fertility:

> *Accordingly, it is certainly reasonable to hypothesize that ovarian failure at menopause is due to an age-related decline in the number and function of GSC such that de novo oocyte production no longer offsets the constant loss of existing oocytes through atresia. In fact, we believe that our hypothesis is much more in keeping with "pure reason and human biology" than the longstanding idea that mammalian of most species, including humans, are endowed with a fixed pool of oocytes at birth that simply erodes away to the point of exhaustion during life (Johnson et al. 2005b: 1475-1476).*

By transforming the definition of ovarian aging and focusing on the role of GSCs, they displace the site of aging to be targeted technologically. GSCs become the cause and thus the target of biomedical intervention. Therefore, their putative existence has the potential to transform the thinking behind ovarian aging, but also very materially to orient research and future possible practices. As a result of the controversy, ovarian aging is thus reconfigured, and the very rare GSCs become both the target and the agent for anti-aging and reproductive sociotechnical projects.

While the existence of GSCs is redefined to fit into the "universality" and the "inescapable fact" of menopause, another range of evidence is questioned and discussed. Not only does the fixed-pool model fit well with the common sense notion of the universality of menopause, it is also supported by years of scientific research as Greenfeld and Flaws (2004) write:

> *While the results of Johnson et al. are suggestive of the presence of GSCs in the adult mouse ovary, some of their data are difficult to reconcile with data from past studies. […] The history of science has abundant examples of the hazards of slavish adherence to long-standing paradigms. […] However the central dogma has withstood the test of time in that it has remained consonant with nearly every empirical*

observation concerning ovarian follicular dynamics in the past 50 years (Greenfeld and Flaws 2004: 831).

Withstanding the test of time, the fixed-pool model relies also upon the sense of the expertise of the scientists who produced these evidences, as noted by Gosden:

> *What is even more persuasive, cytological studies of >500 ovaries from infants and young women have never reported finding these cells (Block, 1952; Lintern-Moore et al., 1974; Peters et al., 1976; Gougeon and Chainy, 1987). Of course, GSC would not have to be conspicuously common to be theoretically capable of generating a trickle of new follicles after birth, but it seems highly unlikely that so many expert microscopists have overlooked pre-diplotene stages in the ovary (Gosden 2004: 195).*

What is expressed in these quotations is that the attested presence of GSC would dismiss the work performed by experts in the field over many years, the repetition of similar results and findings over time making the fixed-pool model unlikely to be totally wrong. The importance of the historical dimension of the fixed-pool model is central in the framing of the controversy in that it is transformed from taken-for-granted, stable, established scientific knowledge, into a "dogma" or even a false belief. While Tilly's critiques stress the fact that the fixed-pool model has remained unchallenged during more than fifty years and that Zuckerman closed the controversy in 1951, the renewal model proponents show that Zuckerman's claims, and thus the "dogma" was never so well established. Indeed they highlight how it is based on preconceived idea about reproductive aging:

> *In our opinion the dogma has never been supported by a single experiment directly and unequivocally establishing its validity. Indeed in a personal reflection of his life in science published two decades after his landmark paper on the dogma in 1951, Zuckerman described exactly how he arrived at the conclusion he did, and in doing so, made two striking revelations. Zuckerman himself spent roughly thirty years believing that adult female mammals could make new oocytes before changing his views in the mid-twentieth century to that of Waldeyer (1870) who initially postulated that oogenesis ceases in mammals soon after birth. He lacked direct proof that female mammals are incapable of oogenesis and folliculogenesis in adulthood, rather the dogma was simply based on his view that none of the data available at the time were inconsistent with the views of Waldeyer (Skaznik-Wikiel et al. 2007: 98).*

By showing how the fixed-pool model is based on a lack of direct empirical evidence, Tilly and his colleagues rewrite the history of oogenesis and consequently of reproductive aging in a way that enables them to reverse the common-sense perspective supporting the "dogmatic" model.

Instead of their data being biased because of not fitting in with the dogma and experiments supporting it, as their critiques assume, they show that the dogma itself was biased and that all the research done since the 1950s is consequently biased in a way, while their research would not be blinded by "false beliefs". In fact the strong belief that the fixed-pool model is true or real becomes the main obstacle to the acceptation of Tilly's results, according to them:

> *Instead, the unwavering* ***belief***[73] *held by some that adult female mammals are simply incapable of oocyte production may be hindering those who have the expertise to directly address this issue themselves from doing so. […] Skepticism is beneficial but we also believe that our field would benefit immensely if those skeptical of our work did not simply continue to offer their* ***opinions*** *from the sidelines but actively participated in the studies they feel are needed, or in some cases have apparently gone so far as to demand (Johnson et al. 2005b: 1472 & 1476).*

They reverse historical evidence supporting the fixed-pool model by transforming it into a dogma and thus a belief based on lack of direct evidence preventing experts from seeing their results in the right way. In this way they explain resistance to the stem-cell model as a resistance to change, as a non-scientific attachment to an unfounded dogma, in contrast with their work that would not be flawed, but would see things in the right way (see also Skaznik-Wikiel et al. 2007).

This example shows how in order to gain acceptance of another model of ovarian aging, and in a sense another reality of ovarian aging, Tilly and his colleagues must rewrite the history of the fixed-pool model by showing that it was not based on direct empirical evidence, but rather on a lack of it, and therefore that once that evidence can be provided, the model proves to be inconsistent. Therefore, in addition to the technical and material work described in the first section, it is by redefining scientific and historical evidence supporting the fixed-pool model that Tilly and his colleagues work to make the existence of germline stem cells in adult human ovaries accepted. Especially it is by negotiating the definition of what a stem cell is, ontology reinforced by the taken-for-granted universality of the menopause, that they challenge the fixed-pool model.

5.4.2. A MATTER OF COUNTING

In the controversy it also becomes clear that the ontological status of these cells and consequently of ovarian aging is not separable from the techniques used to prove or deny their existence. The various techniques used by Tilly and colleagues to attest their existence and isolate GSCs are susceptible of controversy, but an apparently basic technique was much debated,

[73] Emphasis added.

namely the counting of follicles. As the hypotheses and propositions of Tilly stem from a discordant counting of follicles, questions about exactly what is counted, how, and at what time interval become crucial, to the point that the ontological status of these cells and consequently of ovarian aging becomes a matter of counting.

As Tilly writes in an article discussing the reliability of the histo-morphometric technique, counting follicles is not "as simple as 1, 2, 3" (Tilly 2003b). The number of the slices of ovaries, as well as their thickness must be taken into account when estimating and calculating the overall number of follicles contained in an ovary, and the results are highly variable, depending on the strain of mice used, making the transferability of rates of depletion complicated (Gosden 2004). They also depend on the laboratory and the correction factor its scientists use in their estimations. In addition, the number of follicles and their state during menstrual cycles and throughout the lifespan are highly dynamic, making it even more difficult to find absolute numbers.

The great variations observed are "largely biological rather than from counting efforts" (Faddy and Gosden 2009: 231) according to two experts in the mathematical modelling of the follicular dynamics Faddy and Gosden. However, it can "result in apparent (and sometimes quite large) effects being due to chance alone" (Faddy and Gosden 2009: 231). The "subjective" dimension of counting, as well as possible biases due to the materialities and technicalities of counting follicles, are highlighted in the debates as a dubious point of departure for Tilly and colleagues' reasoning:

> *Scoring atretic follicles is notoriously subjective and, while the data are valuable for comparative studies, reliance should not be placed on them as absolute values for calculating the rate of follicular wastage. Histological protocols can create artefacts that exaggerate the true incidence of follicular atresia and the use of harsh fixative in this study might account for the unusual results (Gosden 2004: 194).*

Questions about how snapshots at different times could account for actual follicular dynamics (Albertini 2004), the dismissing of a transformation in the rate of depletion that is inversely correlated with age (Albertini 2004; Gosden 2004), the "unjustifiability" of transferring depletion rates from one strain to another (Byskov et al. 2005; Gosden 2004), all point to the complicated use of the statistical means of estimation of the follicle pool and to the "author's miscalculation of the rate of atretic follicle clearance" (Hutt and Albertini 2006: 6). Recounting, reestimations, and alternative interpretation are then performed in order to prove that the existence of these

cells cannot be established histo-morphometrically (Byskov et al. 2005) and that numbers "do not challenge the conventional theory that oogenesis ceases in mammals soon after birth" (Faddy and Gosden 2007: 1952).

Besides the status of what is counted, the criteria used to differentiate follicles is also controversial, as one can read in the following quotation:

> *While provocative, care should be taken in the interpretation of these morphological results because it is unclear whether morphological determination of the numbers of atretic primordial follicles is completely accurate. […] In addition, atresia of primary and small preantral follicles is very rare. Thus, it is possible that primordial follicles might have been misclassified as healthy or atretic in the study by Johnson et al. (Greenfeld and Flaws 2004: 830).*

Echoing this reflection, others think that the cells Johnson et al. (2004) identified represent "follicular remnants that have been degenerating for many days" (Byskov et al. 2005: 440) or "preantral and antral follicles having entered an atretic state four days earlier"[74] (Gougeon 2005). Illustrating the importance of the quantitative and morphological aspects of the putative GSCs, Tilly and colleagues answer to their opponents' critiques by detailing six lines of experiments based exclusively on the histo-morphometric assessment of follicle numbers at various stages of development and under various experimental conditions (Skaznik-Wikiel et al. 2007), which highlights the extent to which the existence of germline stem cells has become a matter of counting.

While what determines a turn in the controversy is the isolation of GSCs from women's ovaries and their maturation into oocytes *in vivo* (White et al. 2012) that have very few to do with counting follicles, during several years the existence of GSCs becomes a matter of counting follicles, which is not a new technology and has rather been the basic way of examining ovaries since the beginning of the twentieth century. This shows how the ontology of GSCs and thus of ovarian aging depends on mathematical devices assessing the loss of follicles with age, bringing the quantity dimension of the age-related fertility decline to the fore.

5.4.3. WHAT IS AN OOCYTE AFTER ALL?

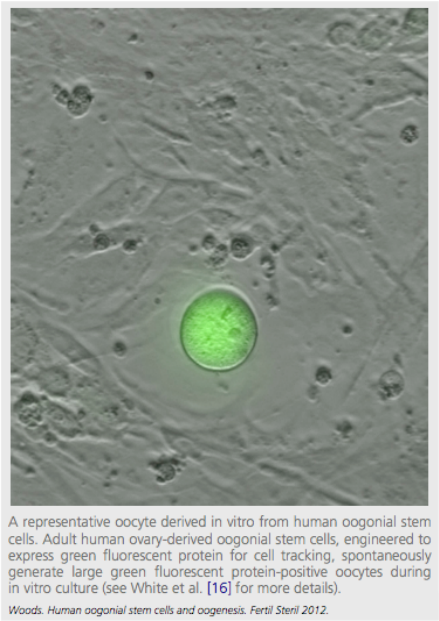
This leads also to questioning the very properties of what an oocyte is. At stake in the debates is the final proof that the cells identified by Tilly and his colleagues would mature into fertilizable

[74] Translated by the author.

oocytes and produce a healthy baby, which would allow the controversy participants to go beyond disputes about the subjectivity of counting follicles. In fact the proof that he is right is "whether those eggs can be fertilized to produce fluorescent offspring" a "result [that] would largely mollify the critics" (Powell 2005: 911). While this is still unproved, this leads Tilly and colleagues to negotiate the criteria according to which an oocyte can be called an oocyte, as one can read in the following quotation:

> *Hence, moving forward, a challenge our field will be faced with is to reach a consensus on what parameters constitute the accurate identification of an oocyte and whether said cell has to exhibit full maturational competency (viz. produce an MII egg that can be fertilized to yield viable offspring) to be considered an oocyte. If maturation, fertilization, and embryonic development competency are now viewed as basic criteria for identifying oocytes, then the last 100 years of follicle morphometry-based studies – including those that formed the basis of the dogma itself could be called into question. To us, this would be unwarranted, because the vast majority of oocytes formed in the ovaries never reach the point of being ovulated as an MII egg, much less fertilized (Tilly, Niikura and Rueda 2009: 9).*

As one can read in this quotation, Tilly and colleagues call into question the very definition of what an oocyte is. Broadening this definition beyond the production of a healthy baby allows them to comprehend the putative GSCs as oocytes. The point is that even though these cells might not produce viable offspring they might nevertheless play a role and sustain ovarian function. As they mention, many immature follicles never reach the maturation stage of an ovulated oocyte, but are nevertheless called oocytes. By redefining the ontology of oocytes, the question of their use in the *in vivo* physiology of women becomes less relevant for these reproductive biologists as can be read in the following quotation: "If you could take these cells outside the body and get them to make a functional egg that can make a normal healthy baby what do you care about the physiology" (Tilly quoted in Gura 2012). This shows how the focus on the putative existence of GSCs leads to a redefinition of both oocytes and ovarian aging where the distinction between *in vivo* and *in vitro* or assisted and physiological becomes less and less significant.



A representative oocyte derived in vitro from human oogonial stem cells. Adult human ovary-derived oogonial stem cells, engineered to express green fluorescent protein for cell tracking, spontaneously generate large green fluorescent protein-positive oocytes during in vitro culture (see White et al. [16] for more details).

Woods. Human oogonial stem cells and oogenesis. Fertil Steril 2012.

Source: Woods and Tilly (2012)

5.5. Promissory work

> *"Absence of evidence is not evidence of absence" Carl Sagan (American astronomer, 1934-1996)*
>
> *"There are in fact two things, science and opinion; the former begets knowledge, the latter ignorance" Hippocrates (Greek physician, 460 BC-377BC)*
>
> *"Every person takes the limits of their own field of vision for the limits of the world" Arthur Schopenhauer (German philosopher, 1788-1869)*
>
> *"Do not follow where the path may lead. Go where there is no path and leave a trail" (Anonymous Chinese philosopher) (Tilly and Johnson 2007: 879).*

This is how Tilly and Johnson (2007) start an article in the bi-weekly journal *Cell Cycle* answering the critiques addressed at their work by researchers having tested their conclusions by partially reproducing their experiments (Eggan et al. 2006; Liu et al. 2007; Veitia et al. 2007). These short quotations from illustrious historical figures characterize the promissory work performed by Tilly during the controversy, in addition to the technical work required to make GSCs exist. Underlying this promissory work is the idea that even though many questions regarding the biology of ovarian aging remain unanswered, it is worth to keep on researching the postnatal production of oocytes in the name of the putative existence of GSCs and the future medical possibilities they open up, as one can read in their positioning in the following quotation:

> *History has taught us time and again that just because a new concept or observation "seems impossible" by some does not, by default, make it so. Instead they often indicate that all of the pieces to the puzzle being considered have not yet been uncovered and accounted for. Our efforts to examine the significance of postnatal oogenesis and folliculogenesis in female reproductive function will therefore continue. We never said we have all the answers, or that our interpretations of the data that exist right now will not, on occasion, require re-thinking as new results become available (Skaznik-Wikiel et al. 2007: 98).*

5.5.1. PESSIMISTS VS. OPTIMISTS

In an article entitled "the current status of evidence for and against postnatal oogenesis in mammals: a case of ovarian optimism versus optimism?" (Tilly, Niikura and Rueda 2009), published in 2009 in the journal *Biology of Reproduction* by the Society for the Study of Reproduction (SSR), this promissory work takes the form of a boundary between "'ovarian optimists' (i.e. those who believe there is some truth behind recent challenges to the dogma that oogenesis in mammals ceased at birth) [and] 'ovarian pessimists' (i.e. those who stand by this dogma)" (Tilly, Niikura and Rueda 2009: 2). For them, and especially Tilly, what characterizes, motivates, and justifies scientific research is optimism. It is the belief that even though uncertainties remain, it is worthy to keep on researching as that is the only way to bring answers, and this in spite of the apparent non-congruence of the findings with some established truths. This optimism can be read in their concluding remark that "although the challenges of pursuing these types of experiments are considerable, being an ovarian optimist helps one stay focused and motivated when tackling complex issues" (Tilly, Niikura and Rueda 2009: 10). In this way, they position themselves among the lonely pioneers daring to go "against the grain" (Powell 2007b) in the name of promising putative cells and promissory futures where reproductive aging could be scientifically and medically targeted and would not be associated with fertility and health problems any longer.

The voluntary attitude of optimistically keeping an eye on the promise lying ahead of their work characterizes Tilly's perseverance regarding the critiques he and his colleagues received. While the existence of the GSCs is still controversial, he positions himself as if their promise was already going to actualize in the present. For example, when asked about what would be the definitive proof of the existence of the cells, that is "produce baby mice from eggs that come from bone-marrow transplants or blood transfusion" (Ainsworth 2005: 609), Tilly answers that he has "tons of experiments under way to address this. Should we do that, it's case closed" (ibid.). The confidence which he constantly displays towards the promise of GSCs to actualize through his

experiments characterizes his tone during the controversy, but also shows how the "boundary-work" (Gieryn 1983) performed to draw the line between what is science and what is not, takes here the form of optimistically believing in a promise to actualize or staying pessimistically fixed on an old dogma in the name of statistics and reason, as one can read in the answer of Faddy and Gosden to Tilly's article cited above:

> *Whilst it is undoubtedly true that absence of evidence is not evidence of absence, the inference that total and primordial follicle numbers behave postnatally as if there is no renewal and only depletion would seem entirely reasonable. This would make us ovarian pessimists, but that is what the statistics say! (Faddy and Gosden 2009: 231).*

The controversy thus divides optimists believing in future promises and reducing the gap between them and actual facts, and pessimists holding to actual facts and stressing the importance of the gap remaining. The scientific truth waits therefore ahead in the future, or lies in the past, depending on which side the scientists are. This temporal boundary between the controversy participants, making them oscillate between a regime of truth and a regime of hope (Brown 2005) indicates also how the ontological status of ovarian aging depends on ways of positioning oneself temporally regarding the possible realization of the promises emerging from Tilly and his colleagues' work.

5.5.2. THE ANTI-AGING PROMISE

While the promissory work performed by Tilly in the scientific controversy justifies his perseverance in researching to prove the existence of GSCs and consequently to show that the fixed pool model is wrong, it elicits many critiques when it comes to its effects on the public. As an example, Tilly is reported to have too optimistically suggested that "a blood transfusion alone could solve infertility" (Telfer et al. 2005: 821), referring to an excerpt of an interview with a journalist published in the *Boston Globe* in July 2005 after the results of the bone-marrow study (Johnson et al. 2005a) came out:

> *We're talking about regenerative medicine here, we're talking about making your ovaries new. […] In Tilly's long-term vision, a woman freezes some of her blood at age 20. Then "you call us on the phone one day and say: "I'm 42, my ovaries are failing: I want to have my ovaries reinvigorated" he said. "They're your own cells; you don't need anybody's approval. They go right into your blood supply and go right to your ovaries", where they mature into eggs. Such techniques probably carry "no down side", no side effects, no invasive procedures, Tilly said (Goldberg 2005).*

After the study of 2012 was published, the prospect of ageless fertility becomes even more present and Tilly is reported to have said:

> *The results offer hope that women are "no longer faced with the idea that there's just a fixed bank account of eggs at birth with only withdrawals and no deposits" Dr. Jonathan Tilly […] told the Wall Street Journal. "I think it opens up the chance that sometimes in the future we might get to the point of having an unlimited source of human eggs", he said (Hastings 2012).*

In association with the prospect of intervening on infertility, proper to the reproductive sociotechnical project, the anti-aging dimension of Tilly's work becomes even more visible, when he compares the GSCs to an "elixir of youth that will allow women to regain the good health they enjoyed when they were young and fertile" (Connor 2012), without any risk of cancer such as in hormone replacement therapy. Or when he says that "to me there is a grander golden chalice here which is ageing itself. It's very clear that keeping the ovaries working has tremendous health benefits on the ageing female body" (Connor 2012). By acting at a reproductive level through the targeting of ovarian aging and the possible extension of fertility, positive anti-aging effects would be obtained as well. This shows how the anti-aging promise emerges from works on reproduction, but also merges with the reproductive promise.

Tilly's promising mode of communication caused much irritation in the field, because of the gap separating Tilly and colleagues' scientific research work from its possible clinical applications:

> *But Albertini says the controversy has been "devastating to the field as a specialty area" because it hasn't been formally resolved. He and others such as Keefe feel strongly that the medical community has been misled into believing there are implications for human fertility preservation. When future therapies fail to appear, it will tarnish the image of reproductive biologists (Powell 2007b: 2752).*

In another article, promoting a "healthy sense of scepticism" (Albertini 2004: 514), Albertini also writes:

> *Like bell-bottoms and The Beatles in the 1960s, the rage of the day here in the new millennium has become stem cells. Unlike the Cultural Revolution 40 years ago, stem cell mania is captivating the attention of the general population as the biomedical research community announces breakthrough after breakthrough with promises of disease cures and now the power to manipulate the building blocks of procreation, namely gametes (Albertini 2004: 513).*

The public image of the field is at stake in this concern for the hype surrounding Tilly's breakthrough promising results, but there is also a sense of anticipated disappointment (Brown 2003) as Tilly's work is part of the "mania" or the "rage of the day" for stem cells that is reduced to the idea of a passing fad raising false promises that will never actualize. Especially a concern for the women suffering from infertility and wrongly hoping that such research might help them is present in the critiques of Tilly's mode of communication. Indeed, while promising to "control the female biological clock and, as a consequence, the timing of age-related ovarian failure and menopause when it might be clinically desirable to do so" (Tilly and Telfer 2009), clinical applications in humans are still very distant. This question is addressed in an article by Woods and Tilly in 2012 where they examine the stakes of passing from basic research findings to clinical applications. They highlight that:

> *The prospect of using human OSCs [oogonial stem cells also referred to as germline stem cells] to produce developmentally competent oocytes in vitro has enormous clinical potential. For many infertile women, oocyte or embryo donation is the only viable option to achieve a successful pregnancy, although the child is not biologically her own. As such, much effort has been put forth to generate oocytes in vitro (Woods and Tilly 2012: 5).*

As attempts to develop embryonic stem cells (ESCs) into competent oocytes have made limited progress, OSCs would provide much better candidates to work as both an anti-aging and reproductive agent. Besides offering good material for further research of oogenesis in vitro, in a field where access to human material is very difficult for ethical reasons (Thompson 2013), these cells have an important clinical potential. In this article, Woods and Tilly describe a new strategy they call AUGMENT an acronym for AUtologous Germline Mitochondrial ENergy Transfer. This seeks to "use the natural energy producing potential of a woman's own OSCS as a means to reinvigorate the same women's eggs for improved IVF success" (Woods and Tilly 2012: 9) with the idea that "autologous OSCs derived mitochondria into human oocytes during ICSI may provide the energy boost needed to overcome existing mitochondrial deficits due to aging or other factors that negatively affect either fertilization outcome or embryonic competency" (Woods and Tilly 2012: 9).

In a way that is similar to the rejuvenating effects expected from ooplasmic transfer (examined in the previous chapter), the idea here is to transfer mitochondria from a woman's own oogonial stem cells in order to rejuvenate old oocytes, that is an autologous transfer, which may avoid the many epigenetic possible problems associated with heterologous ooplasmic transfer (Brenner et

al. 2000; Hawes, Sapienza and Latham 2002). In fact, this technique is already proposed by Tilly's company *Ovascience* in the US and since 2015 in Japan too[75], showing how the promise of GSCs materializes in financial capitalization. The financial value, or the "promissory capital" (Thompson 2005) granted to these cells and the associated promise of regenerating the ovarian reserve, are typical of a biomedical mode of reproduction (Thompson 2005) where the future promise is given more importance than the actual facts (Brown 2005).

The gap between Tilly's optimistic scientific claims, and possible medical uses, while raising much criticism due to the fear of false promises tarnishing the seriousness of the field of reproductive biology, also points to the productivity of uncertainties as a driver to know more and do more research. Instead of undermining Tilly's work, it seems rather that the uncertainties and doubts regarding the existence of GSCs and their use in clinical practices, constitute a condition of possibility for their actualization, as described well by Brown (2005):

> *[…] the uncertainties of present doubt and the potential for future certainty or truths are in dynamic relationship with one another, that is, the present absence of certainty is itself constitutive of the hope for, and drive toward, future truth (Brown 2005: 333).*

Furthermore, the financial investment in the *Ovascience* company shows how these uncertainties and doubts, far from preventing the development and medical use of oogonial stem cells, instead increase the blurring of the boundary between scientific and clinical settings, and generate the promise and the hope for medical applications and thus an investment return, showing how a greater value is granted to future possibilities, than to the "perhaps less-promising realities of present truths" (Brown 2005: 336).

Intermediary remarks

By exploring the controversy on the renewal of oocytes in the adult life of mammals, this chapter has described and documented the technical, material, and epistemological work necessary to make ovarian germline stem cells exist, along with the promissory work necessary to the accomplishment of the first one. It has especially highlighted the shifting ontologies of cells – stem cells and oocytes – whose existence has become a matter of historical and scientific evidence, where "counting" methods have become crucial. The boundary work performed by reproductive biologists along the lines of fantasy versus reality, and optimism versus pessimism,

[75] See the website of the company: http://www.ovascience.com/news/article/ovasciences-augment-fertility-treatment-available-in-japan - accessed on December 15, 2015. The technique is still prohibited in the US due to FDA regulation.

has shown how, in addition, the ontological status of these cells, and consequently of the processes underlying reproductive aging, depends on temporal and moral positioning towards established facts and future promises.

The controversy analysed in this chapter provides a revealing example of the traffic between regenerative and reproductive sociotechnical projects, and illustrates some of the stakes of the focus on aging itself. Firstly, Tilly's work on OSCs stems from attempts to understand cell death, not specific to reproductive functions. He uses reproduction – adult mice ovaries – for anti-aging purposes as he aims at understanding aging processes at the cellular level in order to slow them down or even to reverse them. However, by identifying OSCs in mice ovaries he opens up the possibility of replenishing or rejuvenating ovaries, which would have both reproductive effects – extending fertility – and anti-aging effects – the alleviation of health problems related to reproductive aging, infertility being in one sense only one of them. In other words, Tilly's work results from the traffic of reproductive and anti-aging sciences, and has possibly both reproductive and anti-aging effects. By extending female fertility, other age-related health conditions might be prevented, thus improving older women's health, and meeting the goal of the extension of life characterizing the anti-aging sociotechnical project. In this process, OSCs become both the target of scientific and medical interventions, and the possible agents of reproductive and anti-aging interventions as illustrated by the commercialization of the AUGMENT technique.

Finally, this chapter has also shown how while still far from its actualization in clinical applications, the promise of ageless fertility has already had an impact on the redefinition of reproductive aging at a cellular level, entailing the blurring of the distinction between *in vivo* and *in vitro* which then becomes not so important in regard to future clinical applications as envisioned by the ova cultivation pioneers presented here. Moreover, the analysed controversy illustrates how present uncertainties, and the gap remaining between basic research findings and medical uses, are productive as they constitute the grounding and justification for more research possibly bringing answers and fulfilling the gap, from Tilly's perspective. These elements show how various boundaries between scientific and clinical settings, *in vivo* and *in vitro*, facts, uncertainties, and promises are increasingly blurred as the traffic between regenerative and reproductive sociotechnical projects intensifies.

The three chapters of the first part have highlighted some facets of the traffic between reproductive and anti-aging sociotechnical projects and have documented key moments in the

passage from age to aging. They have shown how statistical age constitutes a condition of possibility for studies focusing on aging itself and have examined the making of the evidence of reproductive aging. They have especially highlighted the role of ARTs in the production of knowledge on reproductive aging and the key role played by transfers implying displacements and transformations. They have shown that multiple ontologies of reproductive aging are enacted and that its nature is not so stable, and is much more controversial that what is usually thought, but they have also highlighted the great amount of work – material, technical, epistemological, promissory – necessary to pass from age – statistical – to aging, and to enact different versions of reproductive aging. While this first part has focused on the production of scientific knowledge on reproductive aging in the international space of scientific research, in the next part we are going to move to the space of the clinic in Switzerland and to explore the experiences of women and couples turning to ARTs to have a child in regard to age-related infertility.

Part II

Living age/ing

Reproductive medicine and the experiences of age and aging

6. The getting real of the age-related fertility decline

I am chatting with a friend in the kitchen as she prepares the meal. She is sharing her experience of infertility, explaining to me why she does not want to turn to ARTS and how she is trying to resist the pressure of other people stressed by the "biological clock", while she actually thinks that she still has time ahead. While outwardly nodding in agreement, I keep thinking to myself that if she really wants a child then she should consult a reproductive medicine specialist. She is over 40, they have been trying to have a child for several years and she has already suffered a miscarriage. In fact, I do not really understand her decision. When going home later, I keep thinking about this discussion and realize how my ideas about age-related infertility and ART's have changed since I started my research. Before, I would probably have agreed with her, saying that she was right to trust herself and her body, that statistics on the fertility decline were just part of some general discourse stressing women and normatively pushing them to have a child at the right moment. Now I was taking the fertility decline to be real enough to think that she had probably not so much of a chance left and that she should seek medical assistance.

How had I started to think that the fertility decline was in some way real? Where did this sense of reality come from? How could something be real in one setting, in one moment, and not in another setting and at another moment? What was implicitly understood when something was said to be real? And how could I reconcile the sense of the reality of the decline with a constructivist approach? Did not real mean essentialist after all? These questions swirled in my head as I was struggling with my own contradictions. As I was reflecting back on my own thinking path, I realized that one thing had changed for sure. I had entered the world of reproductive medicine, if not as a patient, then at least as a close observer and listener. Maybe this moment was a good sign, the sign that I was caught (Favret-Saada 1977) in my fieldwork. But maybe it was a bad sign, the sign that I had lost my critical distance and just believed what the clinicians and patients told me. After all, if the age-related fertility decline was so real for them, it did not mean that it had to be real for me. In any case, I had reported this moment as a significant one. A moment revealing how the age-related infertility could get real in reproductive medicine practices, while being just part of a stressing public discourse outside the clinic. This duality changed the perception of the fertility span: as limited, associated with a sense of urgency and in need of medical assistance in the first case; or as undefined and associated with a sense of relaxedness and the confidence that a child would come when it had to, as my friend expressed in the second case.

This chapter aims to account for the "getting real" of the age-related fertility decline in the context of reproductive medicine, through the notion of materialization. It is an attempt to think about the limits of constructivism and realism or naturalism and to go beyond them. It is an attempt to take what people say and do seriously, or to be naïve on purpose, that is "to take 'things' encountered in the field as they present themselves, rather than immediately assuming that they signify, represent, or stand for something else" (Henare, Holbraad and Wastell 2006: 2). It is also an attempt to account for the agency of the non-human objects and elements that populate the trajectories of women turning to ARTs.

6.1. Apparatuses

The question I ask is how to engage with the age-related fertility decline's reality, to take it seriously, because it matters so much in reproductive medicine, and to show at the same that its nature might not be so stable, or so universal, but also more active, than what is usually thought. To answer this question, Barad's writing, and new materialism thinking following her work, were decisive as it helped me to think about how not only discourse comes to matter, but about how matter comes to matter, or to interrogate "reality" in itself, and its agency as a transformative force. Indeed this line of thinking invites us to apprehend meaning and thing, or the social and the material, as one, as "inextricably fused" (Barad 2007: 3), or as "co-constitutive forces" (Tuin and Dolphijn 2010: 161), that is to focus on mattering processes that are both material and representational. Conjugating Barad's highly conceptual framework of agential realism with empirical data is challenging, as shown very clearly in the reflections of Højgaard and Søndergaard (2011) on the concept of subjectivity in the case of bullying among children. However, the concept of apparatus is crucial for this chapter and I want to present it briefly before going into the empirical data.

Underlying this concept is the idea, inspired by the work of the quantum physicist Bohr, that the properties of objects cannot be separated from the agencies of observation. Barad signifies this inseparability by the term "intra-action", used instead of interaction, a term tending to reproduce the dichotomy (Barad 1998; Barad 1999). Barad borrows the term apparatus from Bohr, who uses it to describe "the intertwining of the conceptual and physical dimensions of measurement processes" (Barad 1999: 4). Thus material-discursive apparatuses do not preexist the object they generate and are not passive instruments. On the contrary they are co-constituted in the sense that apparatuses themselves are part of the phenomena. What characterizes them also is their openness, as one can read in the following quotation:

> *Apparatuses are not preexisting of fixed entities: they are themselves constituted through particular practices that are perpetually open to rearranged rearticulation, and other reworkings. […] Furthermore, any particular apparatus is always in the process of intra-acting with other apparatuses, and the enfolding of phenomena (which can be traded across space, time, and subcultures only to find themselves differently materializing) into subsequent iteration of particular situated practices constituting important shifts in the particular apparatus in question and therefore in the nature of the intra-action that result in the production of new phenomena and so on (Barad 1998: 101-102).*

It entails that "matter can be known differently depending on the apparatus it is known through" (Højgaard and Søndergaard 2011: 345), but also that apparatuses, co-constitutive of the phenomena, are themselves open, even though also constrained. The agential realist approach is challenging and productive in thinking about the question of age in reproductive medicine. While the discursive and socially constructed dimension of age related infertility under the form of "biological clock" discourses and debates on PM motherhood constitutes a self-evident topic of research for social sciences, I argue that its material dimension remains underexplored and that we can learn much by taking seriously the inseparability of matter and meaning.

The first part has already documented the technicalities and materialities necessary to produce knowledge on the age-related fertility decline, and highlighted how multiple versions[76] are generated through scientific practices and promissory work. It has not ignored the materiality of ovarian aging, but the focus was more on the material devices and practices, or apparatuses, upon which the category depends in an inextricable way. However moving to clinical practices encourages the reconsideration of the materialization processes as they take place in individual bodies and trajectories. The reality of reproductive aging is exactly what scientists look for, try to grasp, and somehow miss, as there are always new elements to integrate into their understanding of what reproductive aging is, creating along the way different versions of it. In the IVF clinic, it is what people live in their bodies and experience in their lives. It is what makes them suffer, doubt, or hope. Therefore, this part, and especially this chapter, moves further as it focuses on the materialization of reproductive aging in singular bodies and on its effects for individual trajectories. It assumes that the way in which the age-related fertility decline materializes in the clinic has deep effects on how people live both age and infertility, and hence aims at detailing these processes in the trajectories of people turning to ARTs.

[76] Following Mol (1999, 2002), I use the plural form to point to the "multiple" ontologies that are enacted in practices, and resist the essentialist assumption associated with the word "reality" when it comes in the singular.

Therefore this chapter describes the materialization of age in the framework of reproductive medicine and traces the various apparatuses through which it "gets real" (Barad 1998; Barad 2003). As the three first chapters have already shown, ARTs play a crucial role in the production of knowledge on reproductive aging and its contested nature. In this chapter, I want to go a step further and argue that reproductive medicine, globally, can be understood as an apparatus through which the age-related fertility decline gets real, and that it is itself constituted of many apparatuses that I would like to describe in more details. In addition, the three previous chapters have already paved the way and presented many aspects of the age-related fertility decline, such as statistical age as a risk factor or prognostic of treatment success and failures, ovarian age or "old eggs", the tension and possible decoupling of biological and chronological age, and the fixed-pool model underlying understandings of the ovarian reserve. While these elements, now familiar to the reader, are also present in this chapter, I would like to go further and highlight how they materialize in specific medical practices and how their materialization affect clinicians and especially patients turning to ARTs to have a child.

To do so, I focus on specific moments in patients' trajectories or in clinics where specific "apparatus" (Barad 1998; Barad 2003; Barad 2007; see also Willum Adrian 2015) can be characterized. The goal is to identify the various human and non-human actors, and their relations, generating the realities of the age-related fertility decline. The moments analysed occur at the interface between clinicians and patients, and the goal of this chapter is to account for the daily experiences of age in ARTs treatments, as well as to explore some of the effects of mattering processes. While focusing on patients' experiences, attention is drawn also to the diagnostic tools, measuring devices, and clinical practices, because they are inextricably linked, co-produced, and intra-acting (Barad 2003).

The chapter is divided into four sections exploring different mattering processes through which the age-related fertility decline gets real. The first section questions the status of reproductive aging before starting reproductive treatment and addresses the ways it can be anticipated or not. The second section tackles the ovarian reserve measures, such as counting follicles and measuring hormones levels, that play a crucial role in the materialization of reproductive aging. The third section shows how the reality of the age-related fertility decline emerges as a resisting force through the repetition of failed treatments, while the fourth section turns to the statistics of the decline and the effects they produce.

6.2. Potential age-related infertility

The recent development of the freezing technique of vitrification, used mainly to preserve oocytes, has given rise to the new ontological category of "anticipated infertility" (Martin 2010) by enabling the anticipation of a future diagnostic: "It is not a medical diagnosis, but rather a sociological descriptor for the condition in which one believes one may be infertile in the future" (Martin 2010: 529). Inscribed in an anticipatory logic (Adams, Murphy and Clarke 2009), the age-related fertility decline is considered to be real, concrete, or threatening enough to undergo an invasive procedure, before it gets steeper. In contrast, during my fieldwork, the possibility of freezing eggs was not available and age-related infertility could not really be anticipated. However, it is interesting to have a look at how the age-related fertility decline is enacted before turning to ARTs and starting reproductive treatment.

6.2.1. (UN)ANTICIPATING

In reproductive medicine, up to the time of my fieldwork, there was no tool to identify who is at risk of an accelerated, or premature, fertility decline or to make a prognostic about future fertility. Chronological age was the most widely used factor of risk, based on statistics, that is at a population level, and not on individual genetic biomarkers. This creates a specific situation regarding the ontological status of the age-related fertility decline. To illustrate these points, I want to present an excerpt from a discussion with a woman obstetrician-gynaecologist. Her medical office is in the centre of a big city in Switzerland. As she is very busy, she squeezed me in between two medical appointments with patients. As we sit face to face at her consultation desk, she starts the discussion by asserting the genetic fixedness of the age-related fertility decline. Then she follows by explaining the difficulties of prognosing and preventing the decline:

> *I was saying, it is simple, in terms of pregnancy, the best marker is chronological age. It is known that women's fertility is at its maximum between 18 and 30, and that it decreases after, and for some women sooner than for others, because of unknown factors, that we cannot diagnose preventively. […] Most young women are not aware of or do not want to acknowledge this problem. The end of reproductive life seems very far for these women, busy with their studies, their career, who usually do not have a stable partner. So prevention messages are not really listened to by women who do not feel concerned. Additionally, media, where one can see 45, 50 year-old pregnant women, give the impression that medicine is actually all-powerful and that women can extend fertility as long as they want. But this is all wrong, they do not realize that these women got pregnant with donated oocytes. It is possible to be pregnant spontaneously at*

> *45, of course, but it is an extreme minority. […] The most widespread message, in the field, whatever the country where you work, is that if you have a patient over 35 who does not conceive within 6 months, then immediately you take over, much sooner than with a woman 10 years younger. So there is a kind of urgency. Above all, when you know that most women I see come when they are already 40 or over. They are aware of their age and want to do something before it is too late. And I cannot help but think, it is already too late (Dr. B. 25.01.2012).*

And answering my question on the possibility of a preventive screening of the ovarian reserve, she adds:

> *No, it does not make sense. It is an open door to trouble. If you want, a woman who wants to know where she stands is not in a situation where she can realize her project. What she wants is some prospective information. And we cannot give this information, because it is a dynamic evolution. Additionally, the partner also has an impact. Even though they might seem to be in a good-looking situation, nothing can be guaranteed about their future partner. The evaluation of the ovarian reserve is only useful to predict the success of the stimulation, and to adjust the protocol or the type of the stimulation, but that's it. […] So we are not good at predicting pregnancy. We are relatively good at deciding on the kind of stimulation on the basis of the dosages we have. We can tell a patient: Your ovarian reserve, is good, is in the middle, is weak. But we cannot say whether you can get pregnant or not. We all saw women with hormone levels incompatible with a pregnancy, or even cycles completely stopped, who suddenly have a spontaneous ovulation and a pregnancy, which goes well. So hormone levels are not very useful, except getting you anxious, because if they are bad, they will create a sense of urgency, but they won't help you solve the problem (Dr. B. 25.01.2012).*

In this long quotation, Dr. B. explains firstly how the reality of the age-related fertility decline is not taken seriously enough, and secondly how difficult it is to prevent age-related infertility and how limited she is as a clinician, as there is no tool to measure and anticipate the decline. The tool that she has at her disposal – the evaluation of the ovarian reserve – is not useful for providing an insight into the long-term future reproductive potential of a given woman. It is only useful when oocytes must be stimulated in an IVF cycle, that is to say, in the short term. Additionally, the decline is dynamic, surprising – or not so predictable, when a women who has hormone levels incompatible with a pregnancy, eventually gets pregnant – and women's chronological and biological age is only one element of a future situation. In itself it is not so indicative, because the partner's situation regarding fertility, among other elements, is also to be taken into account and will be highly determining.

In short, the gynaecologist faces a situation where the object to be prevented is not to be anticipated with medical tools. It is dynamic, which means that it evolves in time, is individually variable, and finally depending on many other unpredictable factors. The only stable element – in the sense of commonly shared in the international reproductive medicine field – that she has at her disposal is chronological age as a prognostic of pregnancy rates based on statistics. It is the only element determining for certain her medical attitude. Age is here enacted as an urgency criterion, determining the rapidity of the medical intervention. Depending on the woman's chronological age – over or under 35 – the gynaecologist will wait more or less time before proposing reproductive treatment, age working as a signal to hurry the procedure, or as a signal of a possible wait.

The other tool the gynaecologist says she has at her disposal, which seems not very efficient, is providing women with information. In her narrative, young women are portrayed as unaware of the fertility decline, as having a false perception of their own bodily limits and of the power of ARTs, as well as just being busy with other important activities. Media are pointed out as actors contributing to increase a deceiving sense of ageless fertility, without mentioning the medical and technological process through which these pregnancies are made possible, namely IVF with donated eggs. In this preventive framework, the age-related fertility decline becomes general medical information that concerns every woman, and nobody in particular. Something that is hardly listened to on the one hand, but that could be very stressful on the other hand, if women are not in the situation of carrying out their maternity project. The reality of the fertility decline is taken for granted by the gynaecologist, but this reality cannot be circulated or transmitted, without the socio-technological apparatus making it matter. In some way, we could say that reproductive aging does not exist before reproductive treatment. The only thing that matters is chronological age based on statistics of age and fertility and their famous turning point of 35 years old (Leridon 2004). Age might have an impact on an individual fertility potential, or not, but this cannot be known with precision. This uncertainty and potentiality (Taussig, Hoeyer and Helmreich 2013), in the sense of something that might actualize or not, enacts the age-related fertility decline, as a vague reality that might concern some particular women but without knowing to what extent.

In this clinician's account, age is a risk factor for infertility, and works as an urgency criterion determining the emergency degree of the medical intervention towards the absence of children. The effects of age on fertility are also information that should be diffused, information that can be biased by the presumed power of ARTs, that is hardly heard by young women, that remains

vague and not directly related to specific individuals. How are these aspects of the age-related fertility decline experienced by the women in question? To explore this question, I turn to one woman's experience of the fertility decline before starting reproductive treatment and to the way it is anticipated.

6.2.2. A VAGUE PRESENTIMENT

The case concerns a couple, Emilie and Frédéric[77], in a relationship for seven years and both 38 years old when I first meet them at a consultation with the counsellor of the medical unit I am collaborating with. The second time, I meet them in their recently-built house in the countryside. They make me visit the house, explaining about the construction process and what each room is intended for, including one for the children they are trying to have, but that can be used by children in their family and friends circle in the meantime. After this, we all sit at the table in the dining room. The couple sits on one side and I on the other. I had brought some biscuits, and they made some tea. It is a chilly early evening. They start the discussion by explaining to me how they met and decided to have a child. He starts:

> *F: Well, when we met, we both understood quickly that we would have kids around us. At the very beginning of the relationship we did not ask too many questions, but as the relationship grew stronger, after 6 months, or a year, we said, we want kids together, and that's it, we did not ask further questions.*
>
> *E: Well, I had questions.*
>
> *F: You, you did?*
>
> *E: Yes, I was afraid that time would be against me, so I thought that we might have to try…[…] Because of me, with age advancing (Emilie and Frédéric, 21.06.2012).*

In this early moment of their relationship, both members of the couple share quickly the wish to have "children around them". They project themselves into the future as a couple with children. This wish seems unquestioned, as it fits in with the normal course of things. But she adds that she had this fear that "time would be against her". In this first moment, it is not age itself, it is more vague. It is a fear, a feeling, a vague presentiment that it is already too late or that time might be against them.

She then explains how during a whole year of attempts to get pregnant, she kept track of her menstrual cycles by measuring her bodily temperature daily and recording the results on graphs.

[77] All names are pseudonyms.

This tool helps to assess the duration and the regularity of menstrual cycles. Based on the assumption that menstrual cycles are repetitive, it aims at spotting individual patterns, improving self-awareness of one's own reproductive body. By recording a slight increase in temperature, it also helps to identify the time of ovulation and possibly to anticipate the best moment for conception in later cycles. Menstrual cycles are reported on a temperature chart, but other bodily signs – such as the aspect and touch of cervical mucus or a mild pain in the abdomen – as well as external events which might impact on bodily temperature – such as lack of sleep, alcohol, a stressful event - can be associated with it. These different elements are brought together to make sense of the possible variations in the cyclical patterns and in this case to target better the best moment for conception. These activities can be described as an "un-black-boxing of the patient's body", called "anticipatory socio-naturalization" by Cussins (1996).

After one year of unsuccessful attempts and of tracking menstrual cycles, the couple is referred by her general practitioner to a reproductive medicine specialist. The couple explains to me how this specialist had a quick look at the charts and then discarded them, saying that she was completely crazy to have done that for such a long time, leaving the couple disappointed and feeling cheated. With this example, we can see that before undergoing diagnostic examinations and starting reproductive treatment, the age-related fertility decline is something Emilie is afraid of, but that does not really materialize. What matters are the regularity and length of menstrual cycles, the small variations in bodily temperatures, the timing of sexual intercourse, and the enduring lack of children in spite of these efforts. This presentiment that time would be against her, plays a role however, in the sense that the couple somehow already start to assist reproduction. This awareness is a factor pushing them to increase their control of the process of making a child, to potentiate their chance of conception and make it as efficient as possible. Even though the fertility decline associated with reproductive aging remains more a floating threat than precise information, it is considered to be serious enough to take action in the present. Even though it is imagined as belonging to the future, it is enacted as if it could already be here. Somehow, it matters before it gets real.

This section has shown how before starting reproductive treatment, the age-related fertility decline is enacted in different ways. In the absence of a technology or a tool enabling the prediction or anticipation of its evolution, such as oocyte cryopreservation, chronological age is the main, or even the only, risk factor of the fertility decline, as well as a criterion determining the swiftness of medical intervention. It remains very general knowledge, something that everybody knows, that concerns every woman and no one in particular. It is nevertheless serious enough to

take action in the present, for example under the form of an immediate consultation with the gynaecologist, and/or of the tracking of menstrual cycles and optimal timing of sexual intercourse to maximise chances of conception. What matters is the lack of pregnancy over a determined period of time. In this sense, I would not speak of an ontological category of "anticipated infertility" (Martin 2010), but rather of an ontological category of "potential age-related infertility". The first reason is that it does not concern infertility in general, but the specific kind that is related to age. The second reason is that it is not ignored, women are aware of it, but it cannot be properly anticipated, because of the lack of a tool for materializing it in the present in an individual way.

6.3. Evaluating the ovarian reserve, giving the ovaries an age

> *I was assuming that there would be something, because I had this blocked tube. And then they performed an exam to evaluate the ovarian reserve, since I was already 38. It showed that I had a bad ovarian reserve. They said that I had the ovaries of a 46 years old woman (Nadège, 31.11.2011).*

This short excerpt of a discussion with a woman who ended up turning to egg donation shows how age can be located in the ovaries[78]. While her chronological age is 38, her ovaries are already those of a 46 years old woman. It was the first time I was hearing this in an interview, but not the last one, giving me the impression that it was a common way of speaking in reproductive medicine. This was confirmed when I met an obstetrician-gynaecologist and reproductive medicine practitioner working with a mixed patient group[79], who explained to me how the ovarian reserve could be tested. We are in a well-respected private clinic of Switzerland. He wears a white coat and is under pressure because he may be called at any time for the delivery of one of his patients giving birth. I am sitting in front of him at his consultation desk. He explains:

> *Dr. D.: There is an examination of the ovarian reserve. If you go to our website, it is explained. I performed two this afternoon. We look at the volume of the ovaries with the ultrasound and after, we have a blood test, which shows us indeed if you are 38, if you have ovaries that are those of a 30 years old woman, or of a 42 years old one.*
>
> *NB: You can calculate age?*
>
> *Dr. D.: Yes absolutely. We have indicators, well maybe the woman will say, oh my god, this is a disaster, I have the ovaries of a 42 years old woman, while I am 35, and well yes it is not fair, yes.*

[78] For a genealogy of how age gets located in the eggs and the role ARTs played in this processes, see Chapter 4.
[79] A mixed patients group includes both patient facing infertility problems and turning to ARTs and women consulting for other gynaecological and obstetrical purposes.

NB: Does it mean that women are unequal in the face of ovarian aging?

Dr. D.: Well, yes! It is like when you look at somebody in the face and then you look at her birth date and you say, it is not possible, because either she looks 10 years younger, or she looks 10 years older. And this is hereditary. A woman whose mother was menopausal at age 40, well she is most likely to be menopausal at 40 too, this is classical (Dr. D. 03.02.2012).

In this excerpt of our discussion, we can identify several crucial elements of the making of aged eggs in the clinic. We can see notably that evaluating the ovarian reserve is part of the clinician's daily routine combining two crucial procedures, the ultra-sound evaluation of the ovaries and blood tests. When later I asked another doctor about the possibility of assigning an age to the oocytes (Dr. B. 25.01.2012), she answered negatively and cautiously, explaining that it was a way of providing women with information that they could understand. It was a kind of reduction or a simplification intended for the woman patient so that she could understand what was going on in her body. Of course, it was impossible to really give an age to oocytes. But they seemed nevertheless to be aged. Instead of dismissing this information as wrong or incorrect, I decided to take this assumption seriously because it seemed to say something crucial about age in relation to ARTs and fertility, leading me to ask and observe how age could materialize in oocytes. As the quotations above show, it is through the evaluation of the ovarian reserve that something as strange as an age of the oocytes was produced.

6.3.1. THE FUNCTIONAL AGE OF THE OVARIES

The evaluation of the ovarian reserve is performed at the moment of diagnostic examination, but also during treatment. Along with the tubes and uterus examination, it is the main diagnosis procedure performed at the beginning of a woman's reproductive treatment, in parallel with the evaluation of men's sperm. However, during the treatment cycle, similar examinations are used as a way of controlling the effectiveness of the hormonal stimulation performed, a way of adjusting protocols, and deciding the moment when to block the ovulation with an injection in order to ensure the retrieval of oocytes. There are several ways of evaluating the ovarian reserve, depending on clinical practice. In order to introduce the procedure, I shall draw on an article written by Swiss reproductive medicine practitioners, published in a Swiss medical journal, which explains how the evaluation of the ovarian reserve, or "the functional age of ovaries"[80], is crucial in order to determine the degree of emergency to treat that they call the "medical emergency", in contrast with the "personal emergency" based on subjective criteria (Vulliemoz et al. 2006).

[80] "L'âge fonctionnel des ovaires ou réserve ovarienne". Translated by the author.

The evaluation of the ovarian reserve is based on the fixed-pool model, examined in the previous chapter (Chapter 5), and according to which women are born with a limited pool of oocytes declining in quantity and quality with aging, as one can read in the following excerpt:

> *In women, the number of germ cells is determined during embryonic life. Due to follicular atresia, this fixed number of cells will progressively drop down during the whole life, from the 6th month of pregnancy on. During puberty, one counts usually 300 000 and 500 000 primordial follicles, and only 400 to 500 will be selected for ovulation during the 35-40 years of reproductive life. At the menopause, ovaries have only a few hundreds of follicles left. Some years before the menopause, an increase in the follicle depletion rate can be observed (Vulliemoz et al. 2006: 1)*[81].

As its name indicates, woman's fertility is framed as a fixed and limited reserve of oocytes contained in the ovaries, a certain number of which are recruited each month for ovulation, and that is lead progressively to exhaustion. The image that was used by some members of the medical staff explaining to me what was the ovarian reserve is, was that of a "basket filled with eggs". Each month some of them matured, but only one ovulated and the goal of the hormonal stimulation was to bring them all to maturation, but the stimulation did not deplete the ovarian reserve, or the egg basket.

The examination of the ovarian reserve is based on the crucial notion that the number of follicles growing during a cycle, that is, the follicles that can be hormonally stimulated, is proportionate to the overall number of oocytes remaining in the ovary (Vulliemoz et al. 2006). The exact number of oocytes remaining in the pool cannot be directly assessed, but through this correlation it can be deduced. In this sense, counting follicles or measuring hormone levels works as a proxy for the state of the reserve at a given moment. The goal is therefore to find means or tools for assessing either the number of growing follicles in a cycle, with the idea that it reflects the remaining pool of oocytes, or more directly the degree of depletion of the oocytes pool.

Vulliemoz et al. (2006) mention three main markers of the ovarian reserve used in the clinic: FSH levels at Day 3 of the treatment cycle; counting antral follicles also at Day 3 (or between Day 2 and 4); and the level of AMH that can be measured at any time during the menstrual cycle. In practice, the measurement of hormone levels and the ultrasonographic counting of antral follicles

[81] Translated by the author. Original quote : "Chez la femme, le nombre de cellules germinales est déterminé durant la vie embryonnaire. En raison du phénomène d'atrésie folliculaire, ce nombre fixe de cellules va graduellement chuter durant tout la vie dès le sixième mois de gestation. A la puberté, on compte entre 300 000 et 500 000 follicules primordiaux, dont seulement 400 à 500 vont être sélectionnés pour ovuler durant les 35-40 années de vie reproductive. Au moment de la ménopause, les ovaires ne présentent plus que quelques centaines de follicules. Quelques années avant la ménopause, il se produit une accélération de la perte de follicules"(Vuillemoz et al. 2006 :1).

are always articulated. They become meaningful only in relation to each other and the evaluation of the ovarian reserve results from their combination, as none of them is a perfectly reliable marker of the ovarian reserve. However they also refer to two different medical procedures and enact ovarian age in slightly different ways. That is why I will present them separately for the purpose of the analysis.

6.3.2. COUNTING ANTRAL FOLLICLES

Figure 1 Image de follicules antraux obtenus par ultra-sonographie vaginale effectuée à J3

(Source: Vulliemoz et al. 2006)

The routine of the medical unit is usually cadenced by the successive patient morning consultations, including blood tests and vaginal ultra-sound examination. Counting follicles on an ultra-sound screen is such a daily routine for doctors working in reproductive medicine, as well as for women patients undergoing treatment. The examination itself consists of an endovaginal ultrasound aiming at assessing the number of antral follicles (the maturing follicles) which have receptors to FSH, the hormone stimulating their growth. In order to understand how age can materialize in a number of oocytes on an ultrasound screen, I shall introduce two short scenes, one observed in a clinic and the other encountered and told by patients.

In the first one, I sit next to the doctor of the reproductive medicine unit which I collaborate with for the recruitment of patients. We both wear white coats and my exact status remains unspecified. The doctor is behind the desk and the couple consults for the first time. He is 41, she is 32. They are not Swiss, do not speak much French, and they work for international companies. The doctor performs the anamnesis asking many questions to both partners about their reproductive history, and possible practices or health conditions having an impact on fertility. At the end of the anamnesis, the doctor asks the woman to take off her lower clothes and to lie down on an examining table. The doctor takes an ultrasonic probe, covers it with a plastic film, and carefully inserts it into the woman's vagina. Looking at the screen next to her,

the clinician is able to count 11 follicles in the ovaries. On the screen I can discern some nebulous shapes, but would be unable to count anything. The image looks blurred to me, and I wonder how the gynaecologist knows how to differentiate the two ovaries. The patient, who is apparently well informed, is able to interpret, or to transform, the numbers given by the doctor in terms of her own reproductive potential. At the end of the consultation, she seems extremely relieved and leaves the doctor smiling and saying that she still has time.

A second scene is related by Emilie and Frederic whose beginning of the trajectory was presented above. After their first appointment with a reproductive medicine specialist, they undergo "a battery" of diagnostic examinations. As a result, his sperm is considered to be of good quality according to medical standards in force, whereas her ovarian reserve is found to be very low, and she is diagnosed with premature ovarian failure. After this initial diagnostic phase, they undergo a long journey of reproductive treatment, with many changes of clinics, of protocols, and kinds of treatment, passing from sperm insemination, to IVF, and ending up by turning to egg donation. She reports to me an episode of medical examination during an IVF hormonal stimulation, which she experienced as very hard:

> *The gynaecologist examines me and asks: " Did you do the injections?" and I answer yes. And then he asks: "But how old are you?" I answer that I am 34. He tells me with contempt: "But you have only one oocyte, what do you want to do with one oocyte?" And there I am: "But it is paradise to have one oocyte!". He says: "At your age you should have at least seven or eight of them!" (Emilie, 21.6.2012).*

These two short scenes illustrate how age and fertility materialize in the number of follicles counted on an ultrasound screen. Counting follicles *in vivo* is not possible without an ultrasound device, the expertise of a gynaecologist able to interpret these images, and a woman's body willing to cooperate by lying on a medical examination table and staying still. The woman herself cannot have access to this information. It is only through this apparatus, assembling the doctor's skills, the ultrasound, and the woman's body, that oocytes can be counted, and the state of ovarian aging determined.

Numbers in themselves do not mean much. However, in clinical practices they say a great deal. We can observe how in both cases the number of follicles speaks to the women patients, as well as to the clinician. Counting follicles is a marker of quantity, but it cannot be dissociated from

qualities of bad – which is premature aging and infertility[82] – and good – which is youth and fertility – used commonly by patients as well as by clinicians. It embodies and materializes the reproductive potential of each woman in terms of time left ahead, but also in terms of fertility, in the sense of being able to produce reproductive substance in sufficient quantity, as the second scene illustrates.

These two moments show also how through the counting of follicles and the materialization of age in the oocytes a distinction is drawn between chronological and ovarian age. While this distinction has already been identified in Chapter 4 which documented how age gets located in the eggs at a scientific level, the effects of this distinction are not exactly the same in the clinic. Whereas in Chapter 4, the distinction between chronological and biological age is necessary to the production of knowledge about the biology of reproductive aging and reveals the proximity of the science-clinic interface, in the clinic, it affects the way women live and experience age and fertility.

Both scenes illustrate well how the chronological age of the women is important as a way of contrasting it normatively with the number of follicles they have, which is understood as the age of their ovarian reserve. Chronological and biological age can be aligned, as in the first example, where the state of the ovarian reserve is in phase with the woman's chronological age, or even younger that what she had expected, or out of phase, as in the second case, where ovarian aging is much more advanced than what might be expected at Emilie's chronological age.

In a medical environment dedicated to the maximization of the production of oocytes in order to optimize the procedure (Thompson 2005), which is costly in financial, emotional, and organizational terms, not to be able to produce as many oocytes as one is expected to, is badly perceived by clinicians, as the second example shows. What is at stake is not only the fact that Emilie's individual chances of obtaining a pregnancy with one oocyte are greatly reduced, and that ovarian and chronological age are out of phase, as a sign of premature ovarian aging but also the normative blame or the reproach that she is just not able to produce enough oocytes, making it hard technically for the clinician to do his work properly and for IVF to work. She is considered a bad oocytes producer and her body as unable to produce the reproductive substance needed to perform the procedure. In response to this stigmatization, she asserts the fact that she has at least one oocyte, if not many, meaning that she is still able to produce oocytes, and that for her it is a good sign, the sign that she still has a chance of having her own child. The fertilization

[82] Usually over seven antral follicles is the sign of a "good" ovarian reserve, and less than five is the sign of a "bad" ovarian reserve (Vuillemoz et al. 2006).

that results from the retrieval of this oocyte gives her some reason, even though it does not develop into a pregnancy.

The very low number of oocytes that Emilie has in response to the stimulation will lead the couple to turn to "natural cycles"[83], a procedure entailing a minimum of hormonal stimulation to avoid the risk of impairing the quality of the oocyte, with the idea that the hormonal stimulation is useless – whatever the stimulation, she only has a very low number of oocytes. The goal is thus not to improve the number of oocytes, but to improve the quality, as much as possible, by avoiding taking hormones that might have a negative impact on quality. With this change in treatment, there is a displacement of the focus from quantity to quality, in the sense that one oocyte of good quality is potentially sufficient to create a child. The devaluation associated with the fact of having only a very few oocytes, is thus transformed, in the sense that in "natural cycles" it is normal to have only one or two oocytes in a cycle. Thus, she turns to a medical procedure where her inability to produce many oocytes in response to the hormonal stimulation is not understood as premature aging and infertility, but rather materializes her still remaining chance of getting pregnant. This example shows therefore how depending on the type of hormonal stimulation, the number of eggs counted does not generate the same kind of reality. On the one hand, it is something that prevents ARTs from working, while on the other, it is normalized and is a chance of having a healthy child.

The fact of Emilie's body as unable to produce the minimum needed to perform treatment is experienced as very hard, especially when the couple considers turning to egg donation later in their trajectory. About the importance of having reproductive substance in sufficient quantity or not, she says:

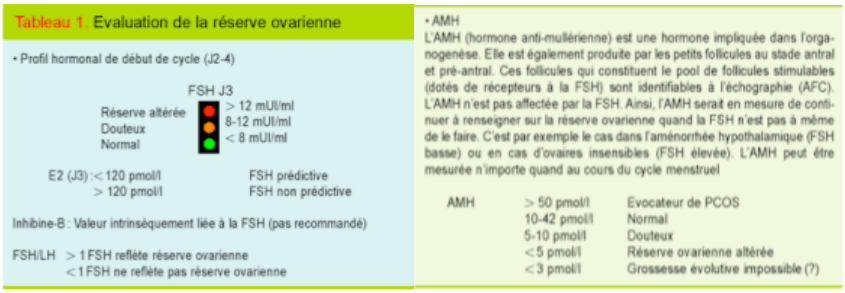
> *Many clinicians told me that it is nothing, it is just a cell, and for me it is really the WORST thing they can tell me, because this is what I lack most, so for me it is not nothing, it is not just a cell, it is this part I am lacking (Emilie, 21.6.2012).*

With this case, we can observe that when age materializes in the number of follicles counted through ultrasound, it is not just a number of reproductive cells. It is not severable from reproductive potential, it entails a different perception of having time, and materializes the chance of having a genetically-related child. In this sense, Emilie resists the isolation of ovarian

[83] For a discussion on "natural cycles" see Thompson 2005, chapter 3, p.96-99.

aging as something purely biological that could be easily substituted, and stresses instead how much this biology is crucial to her possibly becoming a mother.

6.3.3. MEASURING HORMONE LEVELS



(Source: Vulliemoz et al. 2006)

In clinical practices, measuring hormone levels in the blood is part of the daily routine of the clinic. Similarly to the counting of follicles, the procedure is crucial at the moment of diagnosis, but is also performed during treatment cycles in order to monitor the ovarian response to the hormonal stimulation. What is the exact role of these hormones in clinical practices? What do they do? How are they related to age? To answer these questions, let us have a look at what clinicians say about it. The two clinicians quoted below work in private practice as gynaecologist-obstetricians and as reproductive medicine specialists, which means that they have a mixed patients group. The first discussion takes place in the opulent old style-looking doctor's practice. After staying for a moment in the waiting room with other patients, I am invited by the doctor to move to his office. We sit facing each other. Me, with my pen, my sheets of paper to take notes, my shyness and my lack of experience. He, with his white coat, his self-confidence, and his extensive experience. He says:

> *When we discovered what we call the ovarian reserve, which is done with hormonal dosages, especially a hormone called AMH, on which we had based many hopes, we observed that older women had a lower AMH than younger women. Then we thought this is wonderful!! Thanks to AMH we will be able to decide those who are likely to get pregnant, and those who are not likely to be. And in fact it is not true. All we can do with AMH is predict the number of oocytes we will be able to retrieve for IVF for example (Dr. A. 05.12.2012).*

The role of hormones, and especially AMH[84], is crucial to the evaluation of the ovarian reserve. In this excerpt, we can observe a tension between two possible roles for this hormone in clinical practices. Firstly, it is a prognostic factor of the evolution of the ovarian reserve in the future, in relation with chances of getting pregnant. Secondly, it is crucial in the evaluation of the ovarian reserve as a biomarker of its state, at a specific moment, in the present. Both possible roles are in tension, temporally and practically, in regards to what they enable to be done. This clinician expresses the need for a biomarker in the sense of a bodily sign, identifiable and objectifiable, able to sort out women who will be pregnant from those who will not, in a more reliable way than just chronological age which separates women in the broad and unstable categories of younger and older. The dynamic and individual evolution of the ovarian reserve creates a temporal tension between the two possible roles of AMH and explains the disappointment of the doctors about the limited potential of AMH in being able only to give an insight into the current state of the ovarian reserve, but useless to bring the future into the present through an objective measurement[85].

In addition, measuring hormone levels in the blood participates in the enactment of ovarian aging as distinct from chronological age. However, at the same time that it produces this separation, it complicates it as the following moment of discussion shows. I meet the second clinician in her office in a big city of Switzerland. She is in a hurry, but her secretary managed to squeeze me in between two appointments with patients. The doctor welcomes me in a very friendly way and discusses with great interest the question of age-related infertility. She explains to me how to evaluate the ovarian reserve and the complicated role of AMH in this process:

> *There is a count of the follicles, let's say, when it is over seven. Seven small follicles in each ovary, let's say seven to twelve. Well somebody who has less than that has a reduced number. After that, you have to put it in relation with the hormonal dosages, the AMH and the FSH. Somebody who has a high FSH does not have the same prognostic as somebody who has a normal FSH. Somebody who has an AMH at 5 is not in the same category as somebody who has an AMH under 3. A women who is 25, and has an AMH under 5, or under 3 and who has 5 follicles in her two ovaries is not in the same category as a 40 years old woman with the same parameters, because the quality of the one who is younger is better. If we manage to take just one follicle, our chance of obtaining an embryo and a good result in terms of pregnancy is higher than with a patient who presents a physiological ovarian reserve decline. This explains why age is*

[84] AMH is produced by the pre-antral and antral follicles. It provides information on their number, and this independently from the day of the cycle and from the other crucial hormone FSH (Vuillemoz et al. 2006). See Appendix 1 for more information.
[85] The comment of the doctor is also to be understood from the perspective of a biomedicine tending to be more and more personalized with the assumption that it would improve quality of treatment (see Chan and Ginsburg 2011).

so critical. […] We are able to evaluate the quantity, with AMH, FSH, oestradiol. At the beginning we thought that AMH could provide us with information about the quality of the oocyte. But in reality this has not been proven. The most recent studies show that we cannot draw this inference. The only element we use to evaluate the quality is age (Dr. C. 10.01.2012).

In this excerpt, we can observe how women are differently categorized according to their hormone levels of FSH and AMH. Here the hormones work as biomarkers of reproductive potential, not in the long-term, in the future, but in the short-term, in the present of the treatment cycle. Depending on being under or over some predetermined thresholds, the chances of obtaining an embryo and of starting a pregnancy are not the same. However, the clinician complicates this separation, already observed in the counting follicles part of the evaluation of the ovarian reserve. In fact, the same biological parameters, or the same degree of ovarian aging, are not associated with the same reproductive potential, depending on chronological age. While both versions of age are constantly uncoupled, here chronological age comes in by the back door as a crucial determinant. This is made through the distinction between the quality and the quantity of oocytes.

For this doctor, the ovarian reserve – the counting of follicles and the measurement of hormones – gives information only about the quantity of the ovarian reserve, in other words it provides information only about the pool of oocytes remaining in the ovaries independently of chronological age. By contrast, the quality of the egg cell itself is not easily objectifiable. The same degree of ovarian aging is not the same depending on chronological age, because the quality decreases with age. In the absence of tools enabling the evaluation of the quality of the oocyte from the inside, chronological age is used as a default marker based on the idea that the longer the oocytes stay in the body, the more exposed they are to all kinds of stress and external influences, as well as the more they just age along with the rest of the whole body. As this clinician mentions, age is the only marker of quality, age is quality and becomes synonymous with youth and fertility or good reproductive potential, a bad quality being equated with aging and reduced fertility or bad reproductive potential. In other words, quality is age, and age is quality.

In contrast with the use of hormone levels to evaluate the aging of oocytes and fertility potential in the present, or as a predictor of the ovarian response in treatment, on the patient's side to enact age as hormone levels has other effects as well. To explore these effects, let us have a look at Agatha's trajectory. I meet Agatha in the university hospital where she works as a nurse in a big Swiss city. She is 39 years old at the time of our meeting. She has been in a relationship for 10

years and married for 9. She stopped taking the contraceptive pill after a few years of the relationship. In 2007, she decided to consult a specialist in the knowledge that she has tried to get pregnant during almost two years without any success. Through medical examination, her tubes were found to be all right, but her hormones levels were not. There will follow a long medical trajectory with several changes of doctors, treatments, and clinics. She explains the beginning of her treatment, and then how her initial results evolved:

> *There were two things. I started to have swollen breasts, all the time, to the point that it was really annoying, but I was not pregnant. I did not understand what was going on and decided to consult a gynaecologist. They started a medical examination and found a high prolactin level. You know, this can inhibit ovulation. Thus it constitutes already a sign of infertility. And then they investigated and found a pituitary adenoma. The endocrinologist made a report saying that my prolactin level was a little high but could not explain infertility, that I had some hypothyroidism, but there was nothing to compensate, just to watch its evolution. And my FSH level was high. It reached threshold values, just bad enough to prevent things from happening. […] And later I consulted a doctor and he measured the antimullerian hormone, the AMH, and he said "I have some bad news, the ovarian reserve is bad". And we also noticed something else. I had kept track of the duration of my menstrual cycles with calendars, and when I stopped taking the pill, I always had cycles between 22 and 26 days, but never more, and we realized that the oocytes did not reach optimum maturity (Agatha, 11.06.2012).*

About her last medical appointment in a new clinic four years after her first consultation, she adds:

> *And when I consulted this new doctor, they did all the examinations again. And my little levels, which were just a little not good, they had started to get worse. Because of time passing by and of stress. Yes stress. […] Actually I just have a small hormone deficiency, all I have is some hormones which are not sufficient in something (Agatha, 11.06.2012).*

At the beginning, bodily signs such as swollen breasts, annoy her and encourage her to consult a specialist. Through the hormonal examination, the initial mess of bodily signs and absence of pregnancy is differentiated into different problems which all can have an impact on fertility. Among others, the two crucial markers of the ovarian reserve, the levels of AMH and of FSH, are found to be respectively a little too low and too high. The enactment of the ovarian reserve through hormones levels in the blood transforms it into a substance which might slightly vary in some degrees. The differences from normal values are small and associated with the idea that

they could be easily compensated, adjusted or fixed. They are also dynamic, in flux, evolving through time, getting worse, but also sensitive to external influences, like stress, and not just to time passing. More easily than the only oocyte in Emilie's case, hormone levels seem more substitutable and possibly compensated. When age materializes in hormone levels of FSH and AMH, it is more fluid, more dynamic, and apparently more easily medically manipulated. Therefore to enact age in terms of a little bit of hormones to add, provides a less fixed, determined version of ovarian aging. It also tends to diminish the impact of chronological age and of time passing, by creating a version of age-related infertility much more sensitive to external influences, such as stress, than the ineluctability of ovarian aging.

6.4. The resisting force of age

The materialization of age in the oocytes through the ovarian reserve evaluation often occurs at the beginning of treatment, when infertility causes are investigated or when a new treatment procedure is undertaken. The announcement that ovarian aging is advanced, sometimes in spite of chronological age, at the moment of diagnosis may be experienced as a "slap in the face" (Danièle, 13.02.2012), when it is not expected, or when it was vaguely feared, but suddenly gets real, as was shown in Emilie's case. But sometimes age is not a problem at the beginning of the process and emerges as a resisting force only through the repetition of treatment cycles. To illustrate this process of a progressive getting real of age, I turn to Louise's case.

I meet her in the pleasant suburbs of a big city of Switzerland. I come by public transport and we meet at the bus station within walking distance of her apartment. It is spring. The weather is pleasantly warm and sunny. She wears a colourful dress and I notice that she looks young, or rather younger than the other women I have met so far. I think that we must be more or less the same age – I am 31 at this moment – or that she is younger than me. She has contacted me in response to the call for participants that I posted on a forum dedicated to motherhood issues. On our way to her apartment, she starts telling me about her trajectory. Already I knew that the day before our appointment, she had had to do a pregnancy test at home following her last embryo transfer, and she informs me that it has turned out to be negative.

Once we arrive in her modern-design spacious apartment, well illuminated by the daylight, she offers me something to drink and asks me some questions about my own situation, if I have children and how I have came to study this subject. Then, we sit comfortably on the sofa of the living room, I switch the recorder on and she starts to explain her trajectory. She has been in a

couple relationship for about five years. After "acting as a crazy girl" and a student for a decade, she decided that it was time for her to stabilize her sentimental situation. She met her current husband and fell in love with the certainty that he was "the good one". After their wedding, they immediately started attempts to have a child. She was sure that she would come back pregnant from her honeymoon. However, after two months of unsuccessful attempts she realized that something was wrong. She thought that they were young, they were healthy and that if it did not work, then she needed to understand why. They started by doing a spermiogramme and her husband was found to be azoospermic, which means that he has almost no sperm. This came as a violent shock, a "small death" as she says, experienced in a very lonely way and creating many tensions in the couple. After that, her gynaecologist recommended that she go to see a specialist and she made an appointment. She explains:

> *They [secretaries] give you the appointment for about six months later and you tell them you are already 30, because of course you have made inquiries, you have realized that actually, it is not that young any more, I am not 25. And then they give you this appointment six months later for a first check-up. And I tell them: "Listen, Madam, I am already thirty, could you please see us sooner?" – "But 30, it is young, what a fuss you are making?! Ok, if you really want, euh" and then she gave me the appointment for two months later in order for me to complete the forms. You know the kind of things you usually do a quarter of an hour before your appointment. She made me come in two months later, in order to make me stop moaning on the phone. I came, they were so nasty. They were laughing together, and… oh yes and they forgot me in the waiting room (Louise 12.05.2011).*

Age matters here in the sense that it is not considered to be an urgency criterion and consequently that Louise can wait six months before undergoing the first medical examinations. Based on her chronological age, she is considered to have still time ahead and to have a good reproductive potential. The offhandedness of the secretaries regarding her situation contrasts greatly with her feeling that she needs to be certain about her own situation regarding fertility very quickly.

When Louise can eventually start medical examinations, it is found that on her side, everything seems to be all right. The couple starts by undergoing FIV ICSI with the husband's sperm. She receives hormonal stimulation and her ovulation is monitored. Yet, she does not react well to the stimulation. She has only 3 follicles, when she is expected to have more in regard to her chronological age. She explains:

I had only three follicles. [Explaining to me] It is like a pocket with follicular liquid and an oocyte inside or they may be empty. This is the problem as well. Because they say that if there are three and there are three oocytes inside, why not, but as no one is sure, this is why they usually do not do it under four oocytes. And then it depends on age too. […] My FSH was a little bit borderline, it was nearly at the limit. Maybe I hypostimulated, maybe there is something (Louise, 12.05.2011).

Modifications in the protocol of hormonal stimulation enable her to produce more oocytes, but after two more unsuccessful IVF-ICSI cycles, they turn to donor sperm. She undergoes three donor inseminations and as her ovaries respond better to the last hormonal stimulation, the last insemination ends up transforming into an IVF which ends up with a negative result. However, age becomes the reason for their unsuccessful attempts. While at the beginning, he clearly is infertile, through their successive treatment failures, and especially the use of ICSI in a first phase and of donor sperm in a second phase, which cannot be the cause of the non-success of the procedure any more – following a logic already analysed in Chapter 3 on the use of sperm donation programs to isolate "age" – her age becomes the reason explaining why treatment does not work. Age here materializes as the poor number of oocytes in response to the hormonal stimulation. However it becomes also the resisting force preventing the couple from having a child and the reason explaining the treatment failures. To document this change she explains how she felt before starting treatment:

So well, me in my mind frankly, when I think that I went to school for such a long time, I should have known. I had NO idea that for a woman after 40 it became more difficult. I don't know how to say, after 32-35, I had no idea! For me, 20 or 38, same battle! So I was not stressed, at all. Additionally, I was very much a teenager, in my lifestyle. When you are at university, I think that at 27, you are much less mature, than somebody at the same age in professional life. So, for me, it is my friends who told me at 26, that maybe I should be better to stop acting like a fool and start thinking too. They told me: "Louise, the biological clock is ticking!" (Louise, 12.05.2011).

We can see that before discovering that they have a fertility problem and starting reproductive treatment, the notion that fertility declines with age is vague or even unknown, and can be characterized as "potential age-related infertility". The friends play here the role of the social reminder that fertility declines, but also that there are age phases in life where it is appropriate to act in a specific way and that it is getting inappropriate to "act like a fool" at her age. That is, biological and social norms converge in this reminder, where the age-related fertility decline is used as a normative call to follow the socially determined calendars of life.

When her husband is found to have a bilateral cryptorchidism, which means that he is azoospermic, it comes as a huge shock. However in this first phase she is only touched by infertility through her relationship with him, and their common desire to create a family. It is only when treatment cycles do not work, and especially when donor sperm whose quality is controlled is used, that her age emerges as a possible reason explaining successive failures and that the age-related fertility decline gets real. While her partner's inability to produce sperm is clearly the initial reason why they cannot have children, through the use of donor sperm, infertility becomes located on her side and her biological age emerges as an important actor in the ontological choreography of making a child.

Her oocytes do not look so good, according to the biologist and her FSH is a little too high, and they don't have the baby they want, while it cannot be a male problem any more. Her parameters are not frankly bad as in Emilie's case, but just a "little bit" bad. FSH is a little bit too high, and she responds badly to the hormonal stimulation. That may explain why it does not work, but it is not sufficient to explain the treatment failures, and in another case might not have been a problem at all. The age-related fertility decline is just precise enough to materialize in a low number of oocytes and in a level of FSH a little too high, and vague enough, evolving enough, moving enough, to become a kind of general reason for failures. It is what emerges as a resisting force to their efforts and to the treatment, when other objective reasons are found to be inconsistent or can be targeted. Therefore female age-related fertility decline becomes the only factor ARTs cannot do anything about and consequently a kind of overall reason explaining failures.

In contrast with her twenties, when she did not know anything about the fertility decline, and it was only the social reminder expressed by her girlfriends that she should follow the normative stages of life, when I meet her, the age-related fertility decline has a very different ontological status. She is very stressed by time passing. The couple is planning a year abroad for professional reasons, and she is not sure that she can wait until they come back to go on with treatment. She has also become very angry with her mother, who always told her three daughters that they had plenty of time before creating a family and that they should first enjoy life, take time, study and travel. While this maternal message was intended to be emancipating and liberating, it is felt by Louise as a lie. She wishes that she had known that fertility does decline in relation to age, much sooner than what people think generally. She feels that the "you have time" message is hypocritical and entails that her fears are not taken seriously as the experience with the secretaries showed. For example, when her mother keeps telling her that age is not a problem and that she

was pregnant with her younger sister at age 36, it is experienced by Louise as a lack of acknowledgment of her own situation rather than a relaxing message aimed at reassuring her by showing that she has time ahead and does not need to be stressed by age.

In this case, the reality of the age-related fertility decline emerges through the multiple treatment failures that the couple experience. Age materializes in the threshold limits of hormones levels and low number of oocytes in response to the stimulation, but the decline itself materializes as the persistent lack of children in spite of many attempts, and the fact that the male factor gets excluded. Its intermediary status, nor really objectified biologically, not really all right, instead of enabling Louise to diminish its importance, seems to provide a general explanation for treatment failures. More than that, its reality makes it that it can only worsen with passing years thus entailing a race against it.

6.5. Age statistical

We have seen how through the evaluation of the ovarian reserve, chronological and biological or ovarian age are uncoupled. But we have also seen how through the distinction between quantity and quality, chronological age comes in by the back door. In fact, while the age of the eggs is crucial in the determination of reproductive potential and reproductive options, chronological age never ceases to matter during diagnosis and treatment in the form of statistics put in relation with reproductive potential, in the sense of the chance of getting pregnant and of having a healthy baby, especially the chance of miscarriage and other pregnancy complications. Chapter 3 showed how age "alone" becomes a risk factor and a prognostic of success in relation to IVF. Here what I would like to show is how when age materializes in the form of statistics and probabilities, it generates a space of uncertainties and potentiality, which has a very concrete impact on current practices, leading patients to take decisions and orienting treatment.

Franklin (1997) and Thompson (2005) have documented very well the role that statistics play in the culture of perseverance characterizing reproductive medicine. In this section, I am interested in the specific statistics of age. Statistical age is correlated with miscarriages, implantation, and pregnancy rates, as well as with health risks for the mothers. Age statistical is enacted as the chance of having a healthy child or of undergoing miscarriages. To interrogate how age gets real through statistics, I would like to go back to Agatha's case. The last doctor she meets makes her undergo all the medical examinations again, including an evaluation of the ovarian reserve. She says:

I was bruised, when she told me that she could not say that I had 100% chance of not having a child, that she could only say that I had 99%, because there was 1% miracle. […] Sometimes it happens to 42-43 years old women. They suddenly get pregnant, because things make that it can happen, we don't know why, an oocyte develops, sexual intercourse at the right moment, things in the universe that make that it has to happen. When she told me that, I was so upset. It brought tears to my eyes, and I thought this is not possible. I thought I had accepted, I was waiting for that, and I realized that somehow I had kept hoping, and I am confirmed that no. And I think that I am not old enough, there are so many means in this civilized world. Maybe something is going to happen… And she said unfortunately not. It was such a hard hit. […] I cannot say that I don't have any more hope. There is 1%. I don't know when it will really disappear. If my tubes must be removed or I have to undergo a hysterectomy, then ok I will say 100%, but as long as everything is in place… (Agatha, 11.06.2012).

As we have already seen, the age-related fertility decline is a dynamic and evolving process that is sometimes in line with chronological age, and sometimes out of step. However in the description of this moment, statistical age is a reproductive potential reduced to almost nothing. It comes as a hammer blow in the announcement that it is the end of medical solutions, and that nothing more can be done. It is a threshold beyond which only miracles are left. It is enacted as the end of rational solutions, as the coming into play of miracles or forces of the universe. It is not that Agatha's chronological age in itself is too advanced. It is her ovarian age, assessed through the evaluation of the ovarian reserve and put into statistical relation with chances of success, that marks the end of treatment.

We can also see in this quotation that in contrast with other forms of infertility – blocked tubes or hysterectomy, where the organs necessary to reproduction are removed – infertility related to the aging of the ovarian reserve generates more uncertainties. Even though statistics say that there is only a 1% miracle chance, Agatha still has oocytes. Somehow there is still a chance. The lag between chronological age – "I am not old enough" – and statistical age – "1% miracle of getting pregnant" – are conflicting, but the statistics of age are somehow insufficient to kill hope. In this case the statistics correlated with the results of the medical examination, including the evaluation of the ovarian reserve, are ambivalent. They constitute the end of medical solutions, the fact that based on statistics it is rationally not worth to keep undergoing treatment. But on the other hand, they retain hope, in the sense that other women older than her get pregnant and that there must be other technical means. So the lag between statistical and chronological age generates hope. Hope that takes the form of faith in a miracle or in an order in the universe that one cannot control. When age is statistical, it raises an important tension between accepting

things as they are and deciding willingly to search for other means of having a child. In other words, when age is enacted as statistics, it becomes inseparable from the invocation of chance, and entails an active redistribution of agency.

I shall present another case, where the statistical apparatus takes another shape. I contact Sabrina through the reproductive medicine unit I am collaborating with. In meet her in her neat apartment in a big city of Switzerland after a long bus trip out of the city centre. It is the beginning of the afternoon, and she apologizes for the smell of a recent meal. She is 39 and already has a 7 year-old daughter. She has been in couple for 18 years and has just split up from her partner. As the oldest daughter from a family of ten children, living in a foreign country, she is a hard worker and sends them money each month, even though she does not have a well-paid job in Switzerland. Basically, she explains that her partner has "fragile" sperm and that she has "age". She got pregnant easily with her first child, but the second one never came. She underwent her last embryo transfer a few weeks ago, and the pregnancy test showed negative, leaving her with very few options.

She explains to me how she has taken the decision to stop treatment and to leave the happening of a pregnancy to a superior force – in her own words, in the hands of God. After her initial anger, she thinks that if God does not want her to be pregnant with IVF, it is because God has other plans for her. Here age becomes the thing that could be forced or pushed, the nature or the destiny that could be transgressed, while she just has to accept that IVF cannot help. In order to explain her opinion, she draws on the example of a friend who wanted a child so badly, when already older, and whose child happened to have developmental problems:

> *I thought, God does not like me. And my sister said: "How can you say that? Maybe he is keeping you from other things more serious later". I spoke with a friend. She has three kids, and she had the last one at 39 years old. And she told me she just wanted a girl so badly, because she has already two boys, that one day she spoke to God asking for a girl at any cost. She had her daughter, but her daughter has problems. She was born with problems in her brain. She does not walk. She does not speak. She suffers now with her girl. And she told me: "You see if the Lord does not give you something, don't revolt against it, you have to accept, to say it is God's will". It is God's will that it does not work, because the Lord is protecting us, when we do not think he is (Sabrina, 22.02.2012).*

Here formulated in the terms of Roman Catholic religion, the idea that having a child when older or when ovarian aging is already well advanced is like playing with fate was found several times.

Age becomes a limit which when transgressed raises fears of attracting the wrath of God. Age, and especially the crossing over of a "natural" limit, materializes here in the disabled child of her friend and pushes Sabrina to change her attitude towards ARTs and to just accept "the Lord's will". This example shows how for this woman, age materializes in a disabled child entailing that continuing treatment is like chancing God's will, encouraging her to leave the possibility of having a child in a superior force's hands. However, if she had the financial means she would try again, and probably look for other technical solutions such as egg donation, she explains. This entails that challenging Gods' will, or one's destiny depends also on access to certain material means, in this case money, to keep undergoing treatment.

Chancing age-related statistics is like rolling dice. Some people want to try their luck, but others think it is better not to take the risk of challenging fate. Since it is impossible to know in advance whether one is going to be on the good side or on the bad side of statistics, we can see how statistical age entails a redistribution of agency, either as something that can be overcome technically, or as something that must be laid in the hands of a superior force. By creating a zone of potentiality, statistics based on the population of patients may remain very general and not of personal concern. However, through a miscarriage or the disabled child of a friend, they become real, personalized, and materialize the uncertainty related to the possibility of having a child, and specifically a healthy child.

This section has shown how age has an agency through statistics. It enacts reproductive potential and determines reproductive options. It may be an obstacle to IVF only, or to the end of treatment. It may be a miscarriage or a disabled child. It also puts in question very directly the ambivalence between taking a risk, chancing age, trying one's fate, or leaving it in the hands of some superior force.

Intermediary remarks

In concluding this chapter, I would like to return to my initial sense of the reality of the age-related fertility decline and the need which it raised for an anti-essentialist approach to account for it. Turning the attention to processes of materialization through which age gets real in reproductive medicine practices has allowed me to highlight the co-production of meaning and matter. While I have highlighted how the reality of the age-related fertility decline is not separable from various apparatuses, the main one being the measurement of the ovarian reserve, I have

also shown that age can get real through more diffuse forces or resistances, such as the persistent absence of children in spite of several IVF attempts.

While the first three chapters documented the technicalities, materialities and knowledge practices necessary to produce several versions of reproductive aging, this chapter has focused on the materialization of age in individual bodies and singular trajectories, and explored some of the effects that this produces. We have seen notably that through the materialization of age in oocytes, a distinction between chronological and biological age is produced. While they may be uncoupled to some extent, and out of phase with each other, the chapter has also shown how in the clinic they are brought back together. When biological age seems to matter more, as the evaluation of the ovarian reserve plays such an important role in determining treatment options and possibilities, chronological age also plays a crucial role. Indeed it determines the possible wait for and start of treatment, it determines quality to the extent that they become one and the same thing – age is quality, quality is age – and it is something that prevents biological age from being taken seriously, as in Louise's case.

Focusing on various apparatuses has allowed me to show how ovarian age becomes multiple as it is enacted differently: as the counting of follicles, as hormone levels measurements, as a statistic, or as a resisting force emerging through the repetitions of failed treatments. The effects generated by these multiple materializations range from a sense of the ineluctability of aging to the sense of a little something that might be adjusted, including the intervention of superior forces or destiny. Another effect is that markers of quantity – counting antral follicles and measuring hormones levels – cannot be dissociated from qualitative attributes associated with youth or aging, and materialize various reproductive potentials and the time left ahead. The uncoupling of chronological and biological age, generated by the measures of the ovarian reserve, also entails that they might synchronize or be out of phase, differentials imbued with normative judgments about what a body might be able to do at a certain age.

Taking the reality of "ovarian aging" seriously allows us to grasp how the age of oocytes acts back, as it becomes a very concrete obstacle to becoming a genetically related parent, but also how it affects reproductive futures as it materializes the time left ahead and orients reproductive trajectories. However, at the same time that I have shown how age gets real, I have also pointed to the zones of uncertainties and potentiality which this reality generates and which have material effects in the experiences of women patients undergoing ARTs.

The way that reproductive treatment itself generates the realities of the age-related fertility decline, through counting follicles, measuring hormone levels, treatment failures, and statistics, has lead me to argue that as a whole, reproductive medicine works as an apparatus producing these realities. In order to strengthen this argument, the next chapter turns to the specific temporality of ARTs treatment, which has a deep impact on the way reproductive aging materializes in the clinic.

7. Age as a matter of time

When I entered the world of reproductive medicine, I became familiar with new ways of marking, measuring, and experiencing time. People spoke about undergoing exams on D3 or D4. About injections to do at 11 in the evening to stop the ovulation process. About injections to do daily for 10 or 15 days. About blood tests to do before 8 am because the guy from the laboratory comes and after that it is too late. About the impossibility of being in the clinic before 8 am. About waiting for 15 days. And waiting for a phone call from the laboratory. About waiting for the next cycle to start, and waiting for information about the donor, and waiting to know how many oocytes are retrieved and how many are successfully fertilized, and how many developed. About always having to anticipate the next step. About their futures and pasts. About their personal histories and their daily lives. About Christmas, birthdays, and yearly family gatherings. About being unable to advance. Feeling stuck. In association with new ways of marking the passage of time and measuring it, I observed that there were various kinds of time that people had to deal with, and that mattered a lot for them.

This chapter is about the specific temporality of reproductive treatment. The previous chapter showed how the age-related fertility decline gets real in reproductive medicine and focused on several apparatuses through which age materializes. In addition, it argued that reproductive medicine as a whole can be considered as an apparatus through which the reality of reproductive aging is generated. In this chapter and in order to strengthen this argument, I turn to another dimension of reproductive medicine, which is the temporal. Time frames the way in which patients experience age, but more than that, I want to show how it is through a specific temporality characteristic of reproductive medicine treatment, that age gets real. In other words I want to show how the reality of age becomes a matter of time.

This chapter focuses on the patient's experience of age and time in relation to ARTs. To highlight the temporality of ARTs and seize how age emerges as a matter of time, I present one trajectory of patients in depth that I will complement and contrast with examples taken from other cases, but not deepened in the same way. After presenting some elements in the literature on ARTs about the relation between age and time, I will present several facets of the temporality of reproductive treatment through which the linearity and irreversibility of biological time are enacted. I will highlight the tensions and conflicts between different kinds of time, as well as some strategies developed to calibrate them. Examining these zones of tensions helps to capture how age becomes a matter of time.

7.1. Thinking about age through temporality

What are the relations between age and time? A first intuition is of course that they are related, but in what way? Chronological age is a way of marking and measuring linear, or calendar time. It marks the years passed since the day of one's birth and yearly punctuates time. It is also a way of measuring the amount of time – in the forms of years – already passed at a specific moment. Additionally, the age-related fertility decline can be understood as the "accumulation and embodiment of time" (Leibing 2014) or its materialization at a cellular level, in the reproductive cells. The previous chapter has shown how age-related infertility is an individual process, which can be more or less steep and advanced in reference to the chronological age of a specific woman. But in spite of these individual variations, it is characterized by its linear, irreversible and somehow inescapable dimensions. Therefore, even though chronological and biological age may not align in an individual woman, their common linear, cumulative and irreversible dimensions entail that they can easily be taken one for the other, and that they may conflict together with other kinds of temporalities.

Age and time are so strongly connected to the extent that speaking about age is implicitly a way of speaking about time and vice versa. However, chronological age is only one way of marking time, and biological or ovarian aging, only one site where time materializes. Indeed temporality goes beyond age and reproductive aging. To understand better how they might entangle, it is worthwhile focusing on the temporality of ARTs. If reproductive medicine can be understood as an apparatus through which the age-fertility decline gets real, then we can ask how temporality is at play in this processes and how it contributes to the materialization of age.

In social science studies on ARTs, time often remains an implicit theme, rather than being explicitly at the centre of the analysis of ARTs. However, the temporality of reproductive treatment is a recurrent topic (e.g. Earle and Letherby 2007; Franklin 1997; Gentile 2013; Menzies 2000; Thompson 2005) that comes even more into the foreground and is increasingly studied as egg freezing technologies provide new ways of anticipating infertility and suspending or banking time (Martin 2010; Waldby 2014). Three studies are of particular interest for me as they provide crucial keys for the understanding of temporality in ARTs, and especially of the narrative, calibrating, and control dimensions of time.

In 1997, Sarah Franklin in her book *Embodied Progress* highlights the specific temporality of reproductive treatment understood as an obstacle course, by drawing on a narrative approach.

The narrative frame proves useful by focusing the analysis on elements such as beginnings and endings, obstacles and resolution, as well as the seriality of events or causal sequences (Franklin 1997: 12). Additionally, it contributes to accounting for the "progressive, developmental and cumulative linearity of biological time" (Franklin 1997: 12). What is especially interesting in Franklin's analysis is how in reproductive treatment, elements become meaningful only when they are read backwards, retrospectively. As long as the expected outcome is not realized, it is hard for people to know whether the story has reached an end point or not, and to order all the elements of their story. In Franklin's words, couples meet the following dilemma: "how to reach "the end of the story" when neither the causality nor seriality of events can be ordered as a progressive sequence?" (Franklin 1997: 13), thus leaving them in a kind of temporal limbo. Her approach is useful for grasping the uncertainties and the transformation of patients operating during treatment, as well as the retrospective dimension of narratives, where it is only after the end, that the whole story becomes meaningful, and that a coherent narrative can be produced. While Franklin mentions that there is a link between narrative time and biological time, and thus with aging, these relationships are not explored deeply, and age is not directly problematized in regard to the temporality of ARTs.

Ten years later, Thompson (2005) makes another important contribution to the study of the temporality of reproductive medicine. She coins the concept of the "calibrating of time" as an important part of the ontological choreography of making parents to describe the way that people deal with various time scales. She defines the "ontological choreography" as " [...] the dynamic coordination of the technical, scientific, kinship, gender, emotional, legal, political and financial aspects of ARTs clinics" (Thompson 2005: 8). She adds: "What might appear to be an undifferentiated hybrid mess is actually a deftly balanced coming together of things that are generally considered parts of different ontological orders (part of nature, part of the self, part of society). These elements have to be coordinated in highly staged ways, so as to get on with the task at hand: producing parents, children, and everything that is needed for their recognition as such" (Thompson 2005: 8). She identifies two salient coordination processes at stake in ARTs: the grafting of parts and the calibrating of time (Thompson 2005: 9).

The latter concept describes how various time scales are conflicting or competing in the clinical context and refers to the devices used to calibrate and coordinate them. The different times identified by Thompson are the cyclical and repetitive time of menstrual and treatment cycles; the linear and repetitive bureaucratic time which materializes through schedules, agendas, and calendars into which appointments must be fitted; the biological time which is linear,

unidirectional and non-repetitive; the time of first-person narratives; and finally the different temporal histories that give sense to the experiences of patients. This concept allows the highlighting of the difficulties experienced by women and the pressure of the so-called biological clock. Of special interest is her mentioning that each cycle is indeed experienced like a return back to zero by patients, meaning at the same time that biological time is advancing and representing diminished chances of success, as fertility declines with aging.

Although time is presented as an important part of the ontological choreography, she does not study it in depth and the specific temporality of ARTs remains to be deepened. However, her study is crucial to understanding that while we have a dominant perception of time, as linear and unfolding naturally, there are actually a plurality of times and temporalities that are socially and materially organized in the clinic. It is also crucial to understand that in order to make the ontological choreography successful, calibrating time is much needed, making it the result of a work, or of processes, rather that an always already-there category.

The study by Earle and Letherby (2007) on women's experiences of conception follows a similar direction. Even though the categories of time that they distinguish are not exactly the same as those identified by Thompson, they also show how people deal with several kinds of time, namely calendar time, symbolic time, time as commodity that runs out, or as an object, and time as process referring to the biological and social rhythms of reproduction (Earle and Letherby 2007: 237). Not limited to ARTs and rather taking into account the lifecourse of these women where pregnancy and motherhood are considered to be fixed and obligatory passage points in a normal life, this study is nevertheless crucial for understanding the temporality of reproduction through ARTs. In their analysis, the notion of controlling time emerges as central. They show how through contraception and ARTs, there is an increased belief in the ability to control time, which cannot be denied, but also proves itself illusory as unexpected pregnancies and infertility surprise and disturb the planned course of action. Especially they show how control over reproduction lessens with age and time passing. This is of special interest because control over time is a form of power, in the sense that usually people with more power have also more control over their own time, as well as over other people's time (Earle and Letherby 2007).

These studies show how time matters in ARTs and women's experiences of reproduction and how various temporalities are at stake. However, the relation between age and time remains often implicit and is not studied in depth, while I argue that the experience of time which patients go through when facing infertility and turning to ARTs to have a child, the intense work needed to

calibrate various time scales and the sense of having no grasp or no control over time are all elements contributing to enact age as a matter of time.

7.2. ARTs temporalities

Following a call for participants which I posted on a forum dedicated to motherhood issues, Charlotte contacts me with a short description of herself:

> *Hello, my name is Charlotte, I am 39 and I have been in the "hellish circle" of ARTs for four years, in order to have a child with my boyfriend… I underwent two surgical operations for my tubes (that I don't have any more) and this is my second IVF/ICSI (including 6 transfers, all negative except a biochemical pregnancy)… That is to sum up my journey…I remain available for your study…Charlotte.*

I answer quickly and we eventually meet together with her partner in their office in a big city in Switzerland. They work in the same place. As I come by train, we agree that it is more convenient to meet there, near the station, than in their apartment outside of the city. It is early evening and I brought some biscuits. The entrance of their building is closed and she comes to pick me up and shows me the way to their office. All the offices are empty and I have a kind of feeling of transgression for being in a place dedicated to daily work and left without anybody except us. She looks very stylish and elegantly dressed. She leads me to her partner's office. He is dressed more casually and stops working when we arrive. We are all a little bit stressed by the purpose of our meeting, disrupting our daily routines. We thus spend the first few minutes of the meeting trying to get each other to feel more comfortable and at ease.

7.2.1. The time of telling one's own story

After this first meeting, I will meet Charlotte several times, once in her office again, and then, as the relationship becomes friendlier, in restaurants or cafés, mostly after work. In parallel we also keep in touch through email. Each time we meet is the occasion for her to making a pause and distance herself from treatment to reflect on what has been going on. These successive snapshots of where she stands in reproductive treatment provide her with the occasion of choreographing her journey, her identity and the role of the actors of her story, each time slightly differently. Therefore our successive meetings work as an apparatus materializing the passing of chronological time, as each time some new event has happened. This apparatus also generates narrative time. Our discussions never follow a linear path and are not organized in a coherent narrative. Instead she proceeds by going back and forth between present, past, and future,

repeating past elements, reorganizing them, deepening some aspects, leaving others in the background. This momentary disorganization where elements are not assembled in a coherent narrative and follow rather the lines of what matters for her in the present moment, than the lines of a story structured by a beginning and an end, highlights how complicated it is to put together different kinds of temporalities, and how through narration an alternative order to the story can be (re)created.

As Franklin showed, in medically assisted reproduction the end point of the story cannot be reached, as long as the treatment is not finished or as long as a child does not embody the success of IVF. This temporal tension was highly visible as I met Charlotte several times. On the one hand, each time something had progressed. She had undergone additional medical procedures, and displayed an increasing detachment towards ARTs and the enduring absence of children. But on the other, she was still stuck in a suspended time, or "limbo" (Franklin 1997), where the end of the story seemed very close, but also constantly fading further away. Thus the time of our meetings which was not regular and was more dependent on what had happened in her reproductive trajectory, and on our respective personal and professional schedules, provided a site where the tension between linear time, and reproductive treatment time could be expressed.

The temporality of our appointments in relation to her ARTs trajectory is similar to what I found in other patients' trajectories. I met some women or couples several times, and some others only once depending on their situation regarding reproductive treatment. Usually when they already had children by IVF, I just saw them once, but when they were undergoing treatment, I asked to see them several times, in order to grasp the changes operating through the passing of time. The time of the discussions was a temporal disruption in our daily routines and in the usual course of events. Often we had already exchanged some phone calls or emails, but narration in a face-to-face meeting is the specific apparatus through which people took an active position towards what they were experiencing and by which they situated themselves temporarily and choreographed their story.

In their narratives, age information works as a temporal marker enabling the organization of the many elements of the story, situating and accounting for the duration of some life periods, and providing also a point of reference from which to situate their ARTs trajectory. However, as I saw some people several times over several years, age was also present in the sense of months or years passed since the first meeting and materializing the time passed by. In addition, a specific tension was often visible between past elements explaining why and how they had got to the

present moment – namely undergoing ARTs – and the future by anticipating the steps to come. The possible failures especially were anticipated, raising questions about what they would do, whether they would go on with ARTs, would rather stop treatment, turn to adoption, to egg donation, or to other options. But when success was anticipated, questions about the future were also present and focused on the question of having a second child or what to do with the remaining embryos for example. Hence the apparatus of our meetings created a space wherein to (re)create their reproductive pasts and futures.

7.2.2. THE RIGHT TIME/AGE TO HAVE A CHILD

Let us go back to my first meeting with Charlotte and Alexandre. After my explaining the aim of my research and the main topics I wanted to discuss with them, as well as asking for their authorization to record the discussion, she starts by saying:

> *C: So I am going to start with why having a child at this very moment. We started to speak about having a child four years ago, after 6 years of being a couple. I am 8 years older than Alexandre, therefore I have a biological clock problem, a little. And around us, it is true that my brother has children, he had already two at that time, his brother, they have also two, his sister, well we were surrounded by kids, so with years, me, I was of age now of having children, I did not think, I had this idea that it might not be easy, because I know people around me who have had a difficult trajectory, but well we never imagine that it happens to us, of course! And this is it, I stopped taking the pill.*
>
> *NB: Just, how old were you? You are speaking about biological clock…*
>
> *C: I was… then I was 35, 34 in fact, I had not turned 35 yet. And I thought it was the right age, I had enjoyed my life very much, it is true, we travelled a lot, we did many things, so for me it was the moment. For Alexandre less, maybe, well [speaking to Alexandre] I will let you speak, but he is younger, so inevitably the "urgency" aspect, in quotes, is less important for him, of course, but we agreed nevertheless… (Charlotte and Alexandre, 20.05.2011).*

This first moment of our discussion reveals how the right moment to attempt to have a child is determined. First comes the decision to have a child. This is where her story begins. It provides a very good beginning for a story on reproductive treatment. Most often with the other women or couples, the time of narration started with the decision to have a child or with the beginning of the couple relationship. Often too, stories started with an always-already-there desire for a child as expressed in this symbolic sentence: "Well me, I have always wanted children" followed by a temporal gap bringing them to the specific conditions enabling the fulfilment of this initial desire.

More rarely, stories started with the opposite, that they had decided not to have a child, or did not want some, and then explaining how they changed their mind and how they had finally decided to have one. These crucial moments work as a way of ordering the events by setting a beginning to their reproductive journey. They also show that the right moment to have a child is not something naturally generated by the course of life, but rather the result of the complex calibration of different kinds of times.

In Charlotte and Alexandre's case, the determination of the right time to have a child, is negotiated and associated with an action: stop taking the pill. Hormonal contraception by stopping the ovulatory process and thus preventing pregnancy entails that having a child is the result of a decision-making process that must be negotiated in the couple (about the relationship between ARTs and the contraceptive pill see Szewczuk 2012). How is time enacted in this initial moment? What kinds of time, of temporality can be identified? Firstly, Charlotte mentions the time of the biological clock, by which she means the biological time of reproductive aging, which is linear and irreversible. Taking the time of the biological clock into account produces a sense of urgency, an awareness that there is not so much time left after all, and that action needs to be taken in the present, before it is too late. It is differentially experienced by the members of the couple as he is younger and thus has apparently more time ahead to have a child.

Secondly, there is the time of the life course associated with what other people do at the same moment. In this excerpt, the fact that brothers and sisters around them have children, making Charlotte and Alexandre feel "surrounded by kids", works like a mirror of their own situation and as a normative recall that they might have reached a time in life where it is appropriate or desirable to have children. Thirdly, there is the time of their couple relationship starting with their meeting and associated with a specific timing of what can or must be done, and when. It is divided into two phases. There is firstly the phase for enjoying life, for travelling, for consolidating the relationship – I will learn later that this first phase is a way of repairing a prior 10 years relationship, that ended up in a one year marriage and divorce, in which Charlotte experienced many frustrations – and then there is a phase for having children. The way she speaks about the time of their being a couple reveals how usually it is coupled with the time of the life course. By mentioning that she is eight years older than him, she refers to the fact that usually people in a partnership are more or less the same age, and thus share the same relationship to the time of the life course. This time lag between them is a source of worry and tension, giving her the role of the one who wants to hurry, to accelerate, the process of having children, while he is assigned the role of the relaxed one. This discrepancy in their couple is

reinforced by the gendering of biological time associated with reproductive aging, and which matters more for her.

The right moment to have a child, and thus the right age, is the result of the calibrating of these three kinds of time – biological, couple, and lifecourse – through the couple negotiation, where the "biological clock", as she says, with its linear and irreversible aspect plays an important role. Often biological time plays an important role in the determination of the right moment to have a child. For example, Sophie, 39 years old when I meet her, and at the very beginning of her first pregnancy, says:

> *In fact, I met my future husband five years ago. Well, I am 39 years old, so I was 34 at that time. The biological clock was already ticking. I had lived a story with somebody for ten years, so it is not that…. Well my life, I had already more or less already thought about having children with this previous person. But things made that we split up (Sophie 03.05.2012).*

In Sophie's case too, we can observe that the "ticking of the biological clock" plays an important role in the decision to have a child, along with the time of this new relationship. The awareness of the biological clock or of reproductive aging as a linear, non-repetitive, and irreversible time creates a kind of pressure, or in some cases a real sense of urgency. A minority of women expressed that it was the right moment to have a child for them, independently from the biological clock, or independently from their chronological age associated normatively with the time of the life course. But most of them expressed that they felt that they were already too late, that they had to catch up on something, that they were running late, if not in comparison with other people, at least regarding their own sense of "potential age-related infertility". The gendering of the biological clock, materializing time in women's bodies but not in men's, entails that these women feel more the pressure of reproductive aging, and are more proactive in their reproductive journey.

As Charlotte's and Sophie's examples show, the time of the couple and especially of the previous relationship matters considerably, as they both had had long-term relationships before deciding to have a child with a new partner. A previous relationship can appear as lost time, or accelerate the decision to have a child in a subsequent relationship. For example Laeticia, 25 years old, and Pascal, 42 years, old, at the time of our meeting, met after he broke up from a long-term relationship, making her say that he had lost 20 years, which he confirmed. According to her, if he had left this woman at the right moment, he could have had children earlier and would not be

as old as he is now (Laeticia and Pascal, 16.12.2011). The decision to have a child is thus an opportunity to look at one's past with hindsight, and explain how the decision to have a child at a specific moment is the result of complicated calibration between different kinds of time.

7.2.3. The time of diagnosing infertility or waiting without knowing

After determining the right moment to have a child there follows a phase of attempts. Usually people start with what is considered to be the regular way, namely by sexual intercourse. Sometimes they just let it happen, trying not to think too much about it (for example in Agatha's case presented in Chapter 6). Sometimes they have an intense sexual activity hoping to maximize their chances (such as Louise in their honeymoon, presented in Chapter 6). Sometimes they start already to assist reproduction by targeting the best moment in the cycle for having sexual intercourse in order to enhance the chances of conception (as shown in the case of Emilie and Frederic, presented in Chapter 6). This initial phase of attempts may be shorter or longer depending on various elements proper to each situation, such as expectations about one's own fertility, age, sense of urgency, or knowledge about common standards of infertility.

It is important to mention that the medical definition of infertility itself is temporally framed. According to the WHO definition, infertility is "a disease of the reproductive system defined by the failure to achieve a clinical pregnancy after 12 months or more of regular unprotected [implicitly heterosexual] sexual intercourse" (Zegers-Hochschild et al. 2009: 1522). Infertility is thus produced through attempting to get pregnant by sexual intercourse for a certain amount of time. This entails that the duration of the attempts is crucial in the determination of infertility and in the possible intervention of ARTs. Duration plays a role in the decision to turn to ARTs and in the legitimacy of the demand for ARTs. As an example I met a woman, Jasmine, who was 32 when she turned to ARTs, an age at which she already felt she was too old to have a child. In order to be taken seriously and to be accepted for treatment, she told the doctors that she had been trying to have a child for a longer period of time than what the couple had actually tried. Her fear was that if she told the "truth" then the duration of the attempts would not be long enough and she would be prevented from accessing ARTs (Jasmine, 25.04.2011).

What is very specific and characterizes this first phase is a sense of stretched time. It is the first moment in treatment when time starts to matter a lot. Instead of getting pregnant within a few months, an unexpected amount of time starts being spent just in identifying what is causing infertility. About this phase, Charlotte tells me:

So, I stopped taking the pill. I hadn't had my period during a certain number of months. After that, I decided to consult my gynaecologist who just did a little ultrasound and told me: "Well I see something, but it might just be a cyst, I am not sure, go have closer ultrasound examination, there is a very good centre near by". It was a radiology centre, all pregnant women go there, the doctor is very famous. It took 2-3-4 weeks, I don't remember. It takes time. Each time. Each appointment. If it is not for an emergency. And then the gynaecologist tells me: "Well I think it is an hydrosalpinx".

After explaining to me what it is – tubes blocked with liquid – she goes on with telling me about the treatment process:

My gynaecologist told me: " You need to undergo further examination, I refer you to Dr. Monnard[86], she sends many of her patients there. She told me: "To prevent you from wasting your time, because it might be more serious, your friend needs to undergo exams on his side too, because there is not only the woman". And so it is, the machinery set in motion. She told me: " You know, he is very busy, so I am going to insist to him in order that he takes you quite quickly". Well I called him nevertheless, and it took 3 to 4 months before I could get a first appointment. At this moment it seemed so extremely long, now with the benefit of hindsight, I am thinking: "Finally, it was just the beginning, and fortunately we don't know all the things that are going to happen at the beginning" (Charlotte and Alexandre, 20.05.2011).

In Charlotte's case, the decision to consult her gynaecologist is driven by the absence of pregnancy, as much as by the absence of menstruation for a certain amount of time. The absence or irregularity of periods is a bodily sign that something might go wrong with fertility leading her to look for more information from the doctor. In this moment of diagnosing infertility, the amount of time taken by each appointment becomes of great importance. Time stretches as she has to wait for an appointment with the gynaecologist, with the radiology centre, back to the gynaecologist, and finally for the appointment with the ARTs specialist. Time stretches even more when she has to undergo an ultrasound exam again, undergoes the surgical removal of a tube, then wait a few months, then get another ultrasound exam, to finally get an operation on the second tube, and finally start IVF, all of that complicated by the fact that she had irregular periods. She says:

You have to go the third day of the cycle, and then if the cycle does not come, you ask yourself many more questions, and then you have to wait, and then each time, another exam, and each time it takes a month, two months, three months… and for me it was so long. It was long between the moment when I saw my

[86] Pseudonym, like all other names.

gynaecologist for the first tine and the moment when I was told: "Here you are, you suffer from this". It took time, so much time, and for me it was long. Not knowing in fact. After that we are still in uncertainty in the end, because we don't know whether it is going to work or not. But well, then, this period, was almost the most difficult for me (Charlotte and Alexandre, 20.05.2011).

What characterizes this period of identifying infertility's causes in Charlotte's case is that each step takes so much time, producing a stretch of time worsened by the uncertainty prevailing. In this phase, the time of her menstrual cycles is very important, because it dictates when to undergo such and such an examination or procedure. She explains to me how suddenly the regularity of, the interval between, and the length of her menstrual cycles start to matter a lot. Before deciding to have a child, she sometimes had 40 days cycles but it had never worried her. Quite the opposite, she thought that the less it came, the better it was, as it was not something she experienced as pleasant. But as she decided to have a child in agreement with her partner, the time of her periods became very important, firstly as a bodily sign that something was not working, secondly as what determines when some medical examinations can be take, and thirdly as what rhythms this diagnostic phase. The repetitive time of the menstrual cycle is hardly calibrated with the bureaucratic time of medical appointments. Just making an appointment becomes the results of a complicated calibrating of periods time and of bureaucratic time. It can easily take three to four months just to have a first appointment, and then some further months to undergo medical examinations and so on. Overall, it took Charlotte and Alexandre almost a year just to know what their fertility problem was. Waiting without knowing and without being able to undertake anything is maybe what characterizes most this experience of diagnosing infertility.

This sense of waiting and of stretched time can be better understood in relation to the sense of having reached the right time and right age to have a child and start building a family, that Charlotte expresses at the beginning of our first meeting. There is an important conflict between the feeling that it is the right time in her life to have a child and the long wait that the diagnosing phase takes. The awareness that biological linear time is advancing especially is increased by the helpless wait to just finding out what might be causing the absence of children. It is not even beginning treatment. It is just trying to identify at which level to intervene medically and technologically. In fact, for ARTs to work, the first step is to target precisely what the causes of infertility are and where they lie – in the sperm, the oocytes, the uterus, or the tubes, whether it is mechanical or a lower quality of the reproductive substance itself, etc. This information is presented as necessary to the targeting of ARTs. Thus there is no other choice but to wait until

the cause of infertility is identified, knowing that very often no real cause can be found and that unexplained infertility is a diagnostic category in itself (Lipitz et al. 1993; Maheshwari, Hamilton and Bhattacharya 2008). It is therefore an "obligatory passage point" (Callon 1999) characterized by waiting and uncertainty and conflicting with the sense of having reached the right time to have a child, thus increasing the salience of the passage of biological time.

Not surprisingly, in contrast to Charlotte's account of this first phase, that she experiences as very hard, Alexandre says that he does not experience the wait in the same way. He stresses the fact that he is more distanced and relates it to the fact that he never had to undergo medical examinations, except once, when he gave his sperm, and to the fact that he does not have any menstrual period and does not know when they take place. By situating time in his partner's body and letting her deal with the complicate scheduling of the appointments, he is already able to distance himself from experiencing the pressure of time at the very beginning of their ARTs trajectory. During our first meeting, he often insists how different is their experience of time in ARTs, especially due to the absence of his bodily involvement, in contrast to Charlotte. By doing so he performs a dominant or hegemonic masculine identity as distant from, and untouched by, reproductive issue and especially as not threatened by infertility.

Looking retrospectively at this first phase of identifying infertility's causes, Charlotte says that she was fortunate not to know what would come next, because this first experience of waiting without knowing is already something she experienced as very hard. Implicitly Charlotte tells me that it would be even worse later, even though when she remembers this first phase, it was already the worse phase. This example teaches how in ARTs, when people think that they have touched the bottom, they later, retrospectively, realize that actually they had not, and that worse was to come. The wait and the uncertainties do not stop when causes of infertility are identified, when they are. It is an experience that is repeated throughout treatment and even characterizes the whole experience of IVF.

7.2.4. LIVING WITH A CALENDAR IN THE MIND

After undergoing all the diagnostic exams and undergoing a first tube removal, Charlotte has to be operated for the second tube. This second surgery is extremely painful for her as it means that mechanically she does not have any chance of getting pregnant any more. Referring to the popular miracle stories that one can hear in the field of ARTs, telling typically how when people decide to stop treatment or to adopt a child they finally get pregnant, she says that in her case,

miracles are not possible without the medical assistance of IVF. She experiences the removal of her second tube as an irrevocable action that turns her into a sterile person without any chance of spontaneously getting back to her previous status of hypofertile person, and as a loss that she has to grieve for. It changes also irremediably her relationship to IVF as it becomes not only a way of increasing pregnancy chances, but simply the only and unique way of possibly getting pregnant. The doctor, sensitive to her despair, proposes that they start IVF as soon as possible after the surgery, which helps by giving her hope and enabling her to regain a sense of control over what is happening to her.

ARTs treatment imposes a very specific temporality. Expressions such as "I live IVF" or " It is like living with a calendar all the time", or "It is impossible not to think about it", often heard, express the way in which ARTs treatment takes over peoples lives, time, and minds (this aspect of ARTs is very finely analyzed by Franklin 1997). The relevant unit of time in ARTs is the treatment cycle. Starting on the first day of menstruation, people have to inform the clinic via a phone call or a form posted by Internet clinic. It then unfolds following a protocol of highly timed steps, ending, when lucky, in a pregnancy, or, most often, with the beginning of a new menstrual cycle. Let us listen to what Charlotte says about the time of treatment:

> *Because there are so many things to consider, injections to do, ultrasounds, blood tests, it is very packed in three weeks, one lives IVF in fact! Some people tell me: "Oh but you should stop stressing, you should try thinking of something else", but it is not possible! Not when I have to do injections every two days… […] Blood tests must be done about every two to three days. When there are blood tests, there are also ultrasounds the same day. So I had to go do the blood tests before 8 in the morning and it was at A. and we live in B., so it is totally on the other side of the city. Then at 11 practically, you have ultrasounds at the medical office [which is in another place]. So it is true it is a lot of stress. And then the injections that must be done at fixed hours, in the frame of half an hour, in the evening around 19 or 20. So you must organize everything, actually. And then comes the last injection that must be done on a very tight schedule, to induce ovulation, it is around 2 in the morning, more or less. […] Well we know that they have a certain amount of cells, we know that they were retrieved such day, that they were fertilized such day... While in a natural pregnancy, one doesn't know this at all. Well one knows approximately, but one doesn't know, one doesn't care about that. Well this is what people do not understand. It is practically impossible not to think about it. You have to put Utrogestan vaginally, it is 6 per day, still. It is two ova in the morning, two at noon, and two in the evening. Honestly that is almost what bothers me the most, this is not pleasant at all. And then I often set the alarm clock at noon, because I am working and I*

don't necessarily remember it. How not to think about it, it is impossible, isn't it? (Charlotte and Alexandre, 20.05.2011).

In this excerpt of our discussion, Charlotte describes many medical procedures that must be scheduled in order to get IVF or embryo transfer done, with the hope that it will be successful. The very strict schedule of IVF, including hormonal stimulation and its monitoring, the induction of ovulation, oocyte retrieval, fertilization, transfer, and then progesterone taken to increase chances for the embryo to "hang", entails that the awareness of time in the form of hours and days is increasing and constantly present. Additionally, while in non-medically assisted cases the beginning of a pregnancy stays silent and is not even noticed for at least two weeks, in the case of IVF, there is a deep consciousness of the time of embryo development and of a possible pregnancy, strengthening even more the sense of linear time passing, but also meaning the possible escape from the cyclical time of menstruation and treatment.

Charlotte repeats several times that it is impossible not to think about the treatment as it takes over her time and life. On the one hand, medical procedures themselves take a lot of time. Physically, she spends hours just undergoing doing examinations, going to the pharmacy, going from one place to the other, sitting in the waiting room of the lab or of the medical office, driving from the clinic to work, thinking about preparing the injection, preparing it, doing it, cleaning up. On the other hand, time becomes a schedule always in her mind. She develops a sense of ubiquitous calendar time. Medical procedures structure the time of treatment cycle and constrain time in such a way that she is constantly thinking about it, as she has to recall the many appointments and injections, or progesterone ova to take at what time and for how long.

Timetable, or calendar, and clock, are the material devices through which the time of treatment can be organized. They are used to fit in all the medical appointments and procedures and mark the cyclical time of treatment, starting at the onset of menstruation. As Charlotte says, it is like living with a calendar in the mind. Impossible to forget it. The example of the clock highlights the ambivalence raised by the constraining temporality of treatment cycles, and the way in which it conflicts with other kinds of time. She uses a clock to remind her when she has to do the injections, since she is afraid of forgetting it when she is working. Thus on the one hand, the schedule of treatment cannot be forgotten. And on the other, she needs clocks to remind when to perform the injections. This even became a conflict between the couple, when she asked Alexandre to wake her up at two in the morning to do the last injection, inducing the ovulation, and that he forgot because he was too tired and had worked to hard. This episode was still vividly

discussed when I met them. What is at stake is that it entailed that she could not rely on him as a time watcher, but had to be the only one responsible for it, as if she was the only one concerned by the success of the treatment cycle. When she expresses that she would have needed him at her side to do the injection, thus stressing the value of the time of being together, he answers that he did not see any sense in just sitting while she was doing the injection, and that time could be used in a better way.

Time of treatment is extremely constraining and often takes so much time – physically and emotionally – that it ends up conflicting with the time of work and the time of social life. For example, Emilie and Frederic, another couple (already presented in Chapter 6), explain how they became so tired of having to cancel dinners and meetings with friends, of having to justify themselves all the time, that they finally ended up restricting their social life to a minimum. Often couples try to calibrate treatment with their daily life. For example Emma, 33 years old when I meet her, pregnant after 5 years of treatment, explains how she went to Chypra to undergo IVF and seized this opportunity for taking some relaxing holiday time. With the intention of enjoying her time there, she explains how she took injections everywhere in an insulated cool box, and made the treatment adjust to her holiday, doing injections in the car or in the toilets of a restaurant (Emma, 14.05.2012). Laetitia and Pascal, in treatment for a year, explain how because of their work schedule they were not able to get to the clinic before 8 in the morning to undergo the blood tests and how they managed to change the schedule of the clinic to be a little bit looser by making the guy from the lab coming later to pick up the blood samples (Laetitia and Pascal, 16.12.2011). Bastien and Valentine, in treatment for four years, always go together to the clinic appointments and work in the mountains, self-employed in their small company. They explain how as their workload is heavier during the winter, they tend to focus all treatment cycles during summer time and choose the location of their holiday depending on the timing of their treatment (Bastien and Valentine, 14.06.2012). In Charlotte's case, one strategy for calibrating treatment and work times is to disclose her situation to her boss who understands and lets her work with a lot of flexibility. These examples show how people try to calibrate the time of treatment, with the time of work and of social life, through small and individual arrangements and negotiation, and by trying to make the temporal and material constraints looser, with varying degrees of success.

Living with a calendar in the mind, using timetables, calendar, diary, clocks, to organize the time of the treatment and make it fit into one's life, ensures that the temporal dimension of ARTs cannot be easily forgotten. Therefore the treatment cycle increases the awareness that linear time is passing and that one's own time – work and social life times – is submitted to the constraining

time of the treatment cycle, making the goal of treatment and the absence of success so far, impossible or very difficult to forget. While it does not seem to have a direct relationship with age, I argue that living with a clock and calendar in mind, and the increased awareness of time that it entails, contribute to enact biological age as progressively declining, in the sense of linear time passing.

7.2.5. SLOWING DOWN, SPEEDING UP, OR FINDING ONE'S OWN PACE

By imposing its highly constraining schedule during a cycle, the treatment leaves people with little room for manoeuver. A greater flexibility is left to the pace of repeating treatment cycles. Menstrual cycle and treatment cycle must be calibrated. One way of doing it, is to have women take the pill, to stop the production of ovarian hormones and put their cycles back to zero, which facilitates the decision as to when to start the treatment cycle in order to fit the medical schedules. In other cases, women have simply to wait for the first day of their menstrual cycle and then announce it to the clinic. In spite of calibrating the beginning of both cycles, they are not perfectly coupled together in duration. A treatment cycle nearly always takes more time that one menstrual cycle itself. In addition, after transfer women need to recover and wait for their menstruation to come back to start a new cycle, which can take more or less time. This entails that one cycle treatment exceeds the regular duration of the menstrual cycle as it is surrounded by two almost obligatory periods of pause. This means that in ARTs, a treatment cycle takes more time than a menstrual cycle, even if people do not take additional pauses between cycles. However, cycles can be linked together at a more or less rapid pace. Cycles can be undertaken in a rapid succession, and repeated as quickly as it is medically possible, entailing that the overall pace of reproductive treatment is accelerated. In contrast, cycles can also be skipped, timed out, or postponed and the overall pace of reproductive treatment slowed down.

In order to live better with reproductive treatment and to escape from the constraining time of treatment cycles, Charlotte and Alexandre take vacations regularly once or twice a year in order to make a break and not "lose themselves" in the treatment. They usually go to a very distant place where it is warm and sunny and where they can just relax and have a good time. This decision is presented as a way of escaping the calendar in the mind and of not being "trapped" in ARTs. She says:

> *Well, I think that if it does not work with the second IVF, we will move on to something else. On the one hand, I would feel relieved to move on, to just turn the page of ARTs, to not think about it, about the*

appointments, whether we set a date for holidays, whether we schedule another cycle… Because, it is the way it is, one lives permanently with a calendar. We always tried not to plan our whole life according to it. We always took vacations… I had a friend who got pregnant after 7 years, but 7 years, 4 or 5 IVF, I don't know exactly, and they never went on vacation for 7 years! They did everything according to it, and this is something we did not want, it is already difficult enough, so we did not enter this fatal circle, even though it is so easy to be trapped in… So we did it, when we could, and when we wanted to. That said, it is true that during summer, medical offices are closed, and so there is the doctor's calendar too. There is not only ourselves, is there? (Charlotte and Alexandre, 20.05.2011).

If the couple expresses that this time off is necessary to their "moral survival" and to their continuing with treatment, it complicates the time of treatment as well, by slowing it down and by adding some temporal constraints to the already very tight schedule of treatment. It gets even more complicated when the doctor is also on vacation and that Charlotte does not want to go to see a substitute. The notion of a "fatal circle" refers to this rapid succession of treatment cycles that Charlotte and Alexandre try to resist by deciding when it is best for them to plan a transfer cycle. Thus they find their own pace of undergoing treatment cycles including between one and two per year.

Charlotte hyperstimulated to the second IVF and about 50 oocytes were retrieved. Those which successfully fertilized were frozen, which means that the couple has many frozen zygotes[87] remaining and is able to spend a few years just transferring them. This situation is exceptional from what I have seen and heard. In most cases there are only a small number of zygotes entailing two or three transfers, and in some cases such as in Emilie and Frédéric (presented in Chapter 6), people even have no choice but to start new IVF cycles to get a very low number of oocytes – 1 or 2 – due to an already low ovarian reserve. Additionally, frozen zygotes are also somehow safe from the cellular process of aging, allowing Charlotte more flexibility in the planning of treatment cycles, as she does not feel the same pressure of time passing and materializing in reproductive aging, as Emilie does. In this sense, the time of treatment and its specific rhythm – cycles separated by more or less long intervals – is strongly determined by the number of oocytes that can be retrieved, and thus by the ovarian reserve.

In patients' narratives there is often a tension between taking pauses or taking time for oneself to rest, as a condition to go on with treatment, and advancing with treatment, repeating cycles as quickly as possible, to avoid losing time. For example, after the intensity of the first IVF and the

[87] Fertilized oocyte before the fusion of the two pronuclei, containing each 23 chromosomes. See the glossary (Appendix 1).

negative results of the treatment cycles, Sophie, 39 years old when I meet her, explains how she needed to make a pause, and says:

> *I am still young enough, I am going to continue, but before that I need a break. I cannot start again immediately. I really need a break, and we need to find ourselves back too, as a couple… (Sophie, 03.05.2012).*

Paradoxically, the time taken for oneself or for the couple is also a way of improving treatment results, with the idea that the better one feels, the better it is going to work. Indirectly taking time off treatment is also a way of making ARTs work better, all kinds of time deferring in some way to treatment.

The expression "a race against the clock" and we could even say "a race against the biological clock" is probably the best one for referring to the tension between the time of reproductive aging and the pace of treatment. The fear of losing time when it may be already too late, or before it is too late, probably expresses this tension very well. As an example, Louise, 33 years old (presented in Chapter 6) explains how she and her partner plan to spend a year in a foreign country in a very big city, for professional reasons, and how she is torn between her desire to enjoy their year there freely, and starting a new IVF cycle, because she is aware that time is passing, reducing her chance of getting pregnant. Concluding that there is no perfect timing, she says that they will go on with treatment, even though it might not be the best moment for them, and because it has become impossible for her to imagine taking a break and making a pause in treatment (Louise, 12.05.2011). If the time of treatment punctuated by its cycles cannot be paused easily, the linear time of reproductive aging is even harder to pause.

If Louise is trying not to lose time but to take action before it is too late, in some other cases, the tension becomes a real sense of urgency, because it is already "too late". For example, Dalia expresses very well the sense of urgency she feels towards treatment:

> *It is age that puts pressure on us. I am 41 years old, and my husband is…, well it is not a real problem for men, it is especially for women, because fertility declines from 35 years old. […] I cannot wait one year or three months, I cannot wait even one month! So, I have to rush things, even though I have to pay for it myself. So I took the risk of signing the papers, because a baby has no price (Dalia, 03.02.2012).*

Although she had a good job in a neighbouring country, she decided to quit her well-paid and much appreciated work to move to Switzerland to live with her partner. She decided to put

everything on hold because she has the feeling that it was her last chance. "It is now or never" as she says, and she does not want to live with regrets later. She wants to try, even if it does not work, in order not to feel the remorse of having passed her time, or having missed an opportunity, of not having given herself a chance. She takes financial and professional risks because of the urgency generated by reproductive aging, giving her the feeling that she does not have even a month to loose and that she cannot skip a cycle.

Slowing down treatment is associated with the idea of volition (Sandelowski 1990). This idea entails that if you really want a child, you should make the cycles succeed quickly showing that you set it as a priority in your life. To set other priorities, such as education, training, vacation, or time for oneself, can be read as lack of a real desire for a child, and thus as a lack of volition. As an example, Agatha, 39 when I meet her, (presented in Chapter 6) is torn between her decision to start a new professional specialization that she cannot postpone, because it includes some age limits, and the awareness that she might be losing biological time. She feels that if she really wants a child she should set that as a priority. On the one hand she says that her time is already passed, that it is already too late, but on the other, that she has not tried every possibility. She feels that to make her life liveable she should not stay blocked on the treatment, but have other activities, especially this professional specialisation she has just decided to do and which is very important for her. Her ambivalence can be read in the following quotation:

> *It was back in 2007, we are in 2012, it is 5 years ago, I was 32 years old when, 30 when I got married, 32, when we started to think seriously about it, then we decided to go see the doctor, I was already 34, one attempt after the other, the time to change, and well time goes by quickly. Here I am, 39, and I am not able to dedicate 100% of my time to this story of procreation, because now I am committed to this specialised qualification, which takes all my time. […] But now there is this pressure of time, it is really as one says the last hour, if I give up, I can't, I don't want to give up this specialisation, I am committed now, but afterwards there is regret, I feel that if I don't finish, I will regret it my whole life, I will regret that I did not dedicated myself 100% to this story of children, I don't know, and here I am in this dilemma again, in this confusion, in this pro and contra, and all that undermines my self confidence, in the sense that I don't have any certainty, I don't know what to do any more, I've lost the recipe, I've lost the guiding thread, am I doing the right thing? I am going to regret, that's all (Agatha, 11.06.2012).*

Agatha expresses acutely the tension between the pace of treatment and the time of the biological clock. The succession of years and of medical procedures brings her to this difficult dilemma that she should set the attempts to have a child as a priority in her life because it is "her last hour" but

that she has a commitment to this specialisation which she does not want to give up and which is important for her. She anticipates "regrets" as the future feeling, the result of not choosing the right option in the present. Regret, more that nostalgia, is imbued with the guilt that things could have been otherwise, that by making another choice they could have been different. It is also so fraught with uncertainties, as she will never know what would have happened if she had made another choice, in this case dedicating herself fully to reproduction, and giving up the specialised qualification. The irremediable aspect of her choice is associated with the irreversible dimension of biological time and the fact that it cannot be put on hold while she follows the specialisation.

Charlotte also expresses the guilt of slowing down treatment. In contrast with regret, which is temporally experienced as turned towards the past, but is also anticipated as Agatha's account shows, guilt takes place in the present of reproductive treatment:

> *Time, I let it run on, it is true. On the one hand, I realize that is has been 6 months that I let time run on, and 6 months at 39, it is a lot, isn't it [smiling]? It is true, I feel guilty, yes, because if we want to try another IVF, well it would be all that time lost that I am taking now, but well… (Charlotte, 20.12.2011)*

Thus in Charlotte's case the question of age does not come as the stress of having to postpone a new cycle, as in Louise's case. Age comes as a question when she thinks about undergoing a third IVF, and about the age, she will be at the time of "starting again", but not really in the current moment of treatment, when she allows herself the flexibility of planning treatment cycles when it best suits her needs - emotional, physical, in relation to work. People who started their treatment young, like Bastien and Valentine, 28 and 30 years old at the time of the interview, usually say that they feel relieved that they have time ahead, even though they go through many failed cycles. For them even if it takes ten years, they will not be "too old" as parents and they feel lucky in that respect. Especially they feel that they have time to try, and if necessary, to start an adoption process, which also takes considerable time (Valentine and Bastien, 14.06.2012).

While Charlotte skips cycles to make the whole treatment more liveable with, other couples have no other choice but to skip cycles for financial reasons. In Switzerland ARTs treatment is not reimbursed, which means that when a treatment cycle does not bring the expected pregnancy, it is not only the failure, the disappointment which is hard to cope with, but also the fact that people have just lost between 2500 and 10 000 CHF depending on the kind of protocol or transfer they are undergoing. Additionally, repeating cycles means also paying more and more for

a procedure that might hopefully work, but also that might not. For the well-off Charlotte and Alexandre, money is not really a problem, but it adds a difficulty to an already burdensome treatment. During our second meeting, when she shows an increased degree of detachment towards treatment and the absence of a child, Charlotte reflects on the financial aspect of ART's and says:

> *We are lucky enough to be able to access treatment, there are other people who can't, because in Switzerland, you must be able to pay, it is very expensive though, transfers, each time it is 2500CHF with blasto, so it is true it costs a lot, and we are lucky we can afford it. I think I am lucky to be able to at least try, simply (Charlotte, 20.12.2011).*

Charlotte is very much aware of the privilege she has of being able at least to try, even though treatment does not succeed. However, the repetition of unsuccessful cycles is money- and energy-consuming and the repetition of treatment cycles takes here the form of paying for nothing. This financial aspect comes into play when Charlotte and Alexandre think about stopping treatment or undergoing a third IVF. He says:

> *Well, there are two aspects. There is the financial aspect that cannot be ignored, there is a given moment when we can ask whether we are ready to spend so much money in order to procreate, while we can observe that it does not work. And then there is the tiredness aspect, which I think concerns more the woman, it is more burdensome for her, than for men, because we do not need to undergo medical treatment (Charlotte and Alexandre, 20.05.2011).*

Failing a cycle is loosing time, but also losing money. In several other cases, where it was more difficult financially for people, independently from their age, time really becomes money in the sense that they need to slow down the treatment, or stop it for a while, in order to save money and only when they have saved enough can they start a new cycle. In these cases the pace of reproductive treatment is dictated more by the state of the bank account and the possible financial helping hands amongst family members and friends[88], than by the race against the biological clock, or by the need to have time for oneself. The obligation to slow down for financial reasons is very hard when people are older and the time of treatment conflicts with the biological time of reproductive aging.

[88] In many cases, parents helped their children financially, sometimes as a gift, sometimes as a loan (without interest). In one case, friends collected money to help their friends access IVF. This aspect of ARTs treatments could be explored further and is very interesting from the perspective of family relations and kinship. It can unfortunately not be explored within the framework of this dissertation.

Having to decide at which pace to repeat treatment cycles transforms time into a resource that can be lost, saved, and caught up. As the repetition of treatment cycles rests for a large part on the decision of the couple – they can decide to make cycles succeed as quickly as it is medically possible, or they can slow them down for personal, professional, or financial reasons – it is associated with a moral economy of volition where the desire for a child entails that if one skips treatment cycles, or slows them down, it can be interpreted a the sign that one does not really want a child. Uncertainties and ambivalence therefore take the shape of anticipated regrets and guilt.

7.2.6. WAITING, HOPING, ANTICIPATING

Another aspect of the temporality of ARTs is the time spent waiting and the temporal tension created by hope and expectations. IVF is a technology of hope (Fannin 2013; Franklin 1997) (on the question of hope see also Brekke and Sirnes 2011). It works on the promise that it might help a woman to get pregnant and eventually have a child. In itself it is not sufficient. People usually assist conception in additional ways, such as with acupuncture, psychotherapy, or just by having a healthy lifestyle – healthy food, exercise, not smoking. But it is necessary. Without ARTs they have presumably no chance, or a very reduced chance of achieving a pregnancy. People know that it might not work, or that it might be long and difficult, but the promise that it might help them to have a child, at some point in the future, works as a powerful motivating factor in the decision to undergo and go on with ARTs. The wait creates a sense of stretched time, tended towards a promissory future, but also a sense of powerlessness in front of time passing, and especially a sense of feeling stuck, of not advancing, of an eternal present, as the promise of IVF shies away into an increasingly distant future. I was told many times that patience and perseverance are the key words of success in IVF. However, the repetition of failed treatment cycles has an effect on hope, each time the decision to go on, and up to which point, is asked.

When the doctor announces to Charlotte that they are going to start IVF as soon as possible after her second tube removal, it gives her hope and provides her with a sense of regaining control over what is happening to her. However, this initial sense of control is rapidly shattered as the three transfers following the first IVF all have negative results. The second IVF gives her hope again as the protocol of the hormonal stimulation is modified, and as she responds very well – too well – to the hormonal stimulation. However, as she hyperstimulates and cannot undergo a transfer with fresh embryos, she is extremely disappointed. There follows several years of

successive transfers in a succession of hope and a sense of control, and disappointments, or despair, like on a roller coaster. About repeating treatment cycles, she says:

> *At the moment, I am very disappointed, but finally, later, I start thinking about the next transfer. But I am not the kind to think that I don't care because I have other embryos in storage either. I need time to digest, before having the motivation to do it again. Each time I thought: "It is like I am putting myself… I know it is gonna hurt finally if it does not work." I know I am going to engage in something where I will be disappointed, I will cry, I won't feel good. […] For me, it is each time worse in fact. Because in ARTs, nonetheless, the more attempts you undergo, the less chances of getting pregnant you have (Charlotte and Alexandre, 20.05.2011).*

Time here takes the form of cycles of hope and despair. Hope is associated with the beginning of a new cycle or new transfer, where each time something is done slightly differently. For example, a change in the hormonal stimulation protocol is decided, or a transfer with blastocysts at day 5 instead of 3-day-old embryos is attempted. A specific moment in the ARTs treatment, when wait and hope intensely intertwine, and that especially crystallizes the tension and ambivalence presented above, is the 15 days following embryo transfer. This period of waiting is known to be one of the worst moments in treatment. Some women whom I met decided to take medical leave during this period, or wondered whether they could go in for sport or whether they should rest. Most of them were preoccupied with any bodily sign such as breast tension, tension in the lower abdomen, swinging mood, special vaginal secretions, or any other bodily sign that might deviate from the normal state of the body and thus signal a change of status from the cyclical time of being non-pregnant to the developmental time of pregnancy. It is the moment when hope is as its maximum, and as a correlate the possibility of being disappointed, one more time, reaches its highest peak too. Women have no choice but to wait for 15 days, until the hormone, beta-HCG reaches a level that can be detected in the blood or in the urine. The pregnancy test can be performed in the lab or the clinic, confirming or not the pregnancy. Women can also do a urine pregnancy test at home, a few days in advance. Hormones might be technically detectable, but with the risk of having a false negative or a false positive, in case the embryo stops growing. For this reason many women prefer to wait for the exact day to have the "official" blood test, in order to avoid any false hopes or false disappointments. About this moment, Charlotte says:

> *For me, it is not the treatment itself, which is the most burdensome, it is really the purpose, it is really what is at stake, the answer, when I have to phone, and that I can already hear the secretary's voice, I hear it and I already know what she is going to say… She is going to say, listen, I am very sorry… this*

is it, at the end, I phone with a knot in my stomach, and the day is very hard. Afterwards it goes away. It goes away a little bit faster, but it is nevertheless more and more difficult for me, for me it is the most difficult (Charlotte 20.12.2011).

The phone call that she has to make 15 days after the transfer materializes the hope invested in believing in the promise of IVF and the correlated fear of being disappointed one more time. She anticipates the negative answer but still has hope, as hope is hard to kill, and if she did not have hope, then she would not to do it any more. This ambivalence gets even worse when she experiences what is called a biochemical pregnancy, which means that the first result shows that she is pregnant, but instead of doubling each 24 hours, her beta-HCG hormone levels decrease instead, indicating that no pregnancy is beginning. She explains how on the one hand it was even worse, because she was starting to believe that it might work, but on the other, it was a new step, something she had never experienced before, it was a level in pregnancy that she had never reached before, it was something new in the linearity of the process of embryo development, implantation and growth.

In Charlotte's case we can also see how the repetition of transfer cycles, associated with the repetition of dashed hopes entails an erosion of hope, as the promise of IVF gets more and more utopian. Each cycle renews hope, but at the same time, to protect herself, Charlotte ceases fully believing in it. The ambivalence between believing, hoping, expecting the promise of IVF to work, and protecting oneself against the fall, the despair, which is proportionate to the hope invested is very intense:

I think: "I don't believe", but deep inside, I want to believe, otherwise, I would stop everything. Each time I think: "I stop everything, I don't want to do this anymore, we stop everything"…And after I go on, because there are still embryos, I think: "Perhaps among the 16 embryos remaining, one is THE good one, or maybe not" (Charlotte and Alexandre, 20.05.2011).

The cyclical time of treatment in an alternation of hope and despair strengthens the feeling of being stuck or trapped, of making no progress and standing still, or of putting one's own life on hold. By turning everything towards the promise of having a child and the sense that it could happen with the next transfer, Charlotte lives her life in the expectation of this positive outcome. Very concretely, she does not want to change her job because she might be pregnant and then she would loose the good conditions she benefits from there. She also does not want to start a new specialised qualification, because she would have to stop if a baby came. She bought a family

car big enough to install the car seat for her possible children. She did not really like it, but it was chosen in relation to the hope of having a child soon. As she gets tired of hoping in vain, she decides to buy a smaller car, sportier, not appropriate for a family, but giving her fun. This decision is part of her process of disengaging from treatment cycles, but shows also how everything is put on hold and turned towards the hope of a potential child, giving a sense of suspended time and of not advancing. The repetitive and cyclical time of treatment generates the sense of feeling stuck, trapped in the repetition of the present, while linear time – of biology and of the life course – is passing. In contrast, Alexandre took the opportunity of this life without children, as an encouragement to do a lot of training and certificate courses, and advance his career, while she felt stopped in her career, even though she had no child.

A metaphor that is widely used in the ARTs community gathered in the Internet forum where I contacted people is the image of waiting on a platform to embark on the train of pregnancy. The feeling of being stopped, of not being able to advance, of being caught in the repetitive time of treatments, of the alternation of hope and despair, is even strengthened by external events recalling that while one is being caught up in the present of the treatment, others are advancing in their lives. For example Louise explains how Christmas, Easter, and other family celebrations, all repetitive events, marking the passage of years, are a source of despair, by reminding her that she still does not have the child she is longing for and trying forcefully to have, and that she is unable to move on the next step of the lifecourse, namely becoming a parent (Louise, 12.05.2011). Friends' weddings or pregnancy announcements are other sources of despair by recalling that other people are progressing, advancing in their lives, while one is not, as Charlotte explains in the following quotation:

> *I don't want to lock myself in this thing, becoming embittered because I don't have kids and resenting the entire earth. Because at the beginning there are times like that, it is difficult to see all these pregnant women, of going where there are many children, or at Christmas parties, when we are trying to, it is really tough, because we are left behind, let's say (Charlotte, 20.12.2011).*

The alternation of hope and despair and the repetitive time of treatment cycles generate the feeling of being caught in the present of treatment without being able to escape, to embark on the train of pregnancy, where the linear time of embryo development would start to matter more. Age in itself is not especially at stake in this moment. However, as years of treatment pass, the sense of not being able to advance in one's own life, to access the next step of the lifecourse, is increased by the awareness that reproductive substance is declining and that chances are getting

slimmer and slimmer. As Charlotte says when she projects herself into the future and the possibility of undergoing a third IVF: "If it did not work when I was 38, it won't work at 40" (Charlotte, 20.05.2011). Thus age emerges as the linear and inescapable time of the biology of reproductive aging, in contrast with the repetitive time, cyclical time of treatment, the fatal circle, as she says, where one is stuck in a kind of repetitive present, tension reinforced by the time of the life course where other peoples' advancement works as the mirror of one's own immobility.

Illustrating well the wait and ever disappointed hopes, is when people calculate the actual chances they have had in the form of treatment cycles and the years passed since this very moment. For example, when Bastien and Valentine look retrospectively at their reproductive treatment trajectory, they reach the bitter conclusion that while other couples can try to have a child each month, they underwent only 7 transfers, in 5 years. This means that they actually have had seven chances of achieving a pregnancy, in contrast with people trying without medical assistance and able to try again each month, without interruption, for whom these 7 transfers would correspond to only 7 months or 7 menstrual cycles. This highlights very concretely the tension between the cyclical time of medical treatment and the linear time of reproductive aging and years passing (Bastien and Valentine, 14.06.2012).

As treatment cycles are turned towards a promissory future, after each treatment cycle the question of how long to continue, and whether one should turn to another clinic, or another reproductive option – egg donation, adoption – is asked. This creates a temporal tension where while a positive result is hoped for, a negative result is anticipated, as well as a plan for action for the next steps of treatment. Thus there is a real tension between the future-orientation of treatment and its cyclical repetition, in regard to the linear and irreversible time of biology.

7.2.7. TIME TO STOP? OR IMAGINING A FUTURE WITHOUT CHILDREN

A final aspect where the temporality of ARTs matters greatly and intertwines with age concerns the end of treatment. Most scholars writing on ARTs have shown how difficult it is to stop treatment and to put an end to ARTs (Becker 1994; Franklin 1997; Thompson 2005). Statistics and hope keep nourishing the sense that it might work next time and that all chances are not exhausted. Sometimes the repetition of treatment cycles works as a positive factor, as when Alexandre says that for him statistically, that is rationally, it must work once, so the more they try, the more chances they have that it will work at least once. Sometimes, the repetition of treatment works as the exhaustion of hope leading to an increased detachment, as is the case for Charlotte.

Here the length of the treatment, the time spent thinking about timing medical procedures, doing daily injections, the sense of not advancing, of feeling stuck in repetition, lead her to consider seriously the ending of treatment which in her case means not undergoing a third IVF and not turning abroad to egg donation, or another kind of treatment that might be appropriate.

Each time I see Charlotte, there is clearly ambivalence between giving up on continuing with ARTs, or trying one more time but it gets increasingly transformed in the certainty of not wishing to continue. She has the sense that she has already spent too much of her life just trying to have a child and wants to think about herself and accomplish herself in other kinds of projects. While in the first meeting, Alexandre displayed more detachment, she becomes increasingly detached, and he becomes the one who wants them to go on. In the meantime he has lost his father, which increases his desire to have a child especially in relation to the anticipation of his own illness and death and his wish of not wanting to age and die all alone, without any family around. Even though they are very close to their nephews and nieces, spend vacations with them, and take often care of them, when he thinks about the end of their life, he thinks only about the close nuclear family including their possible own biological children, and he has this feeling of loneliness that increases his desire to have children, as embodying the future.

At stake is the possibility of imagining one's own future without children. Thinking about the end of treatment is also being able to project oneself into a future without children. Children embody the future, the next generation, the ones something can be passed on to. As Sophie says nicely, she wants children to teach her about "the continuation of life" (Sophie, 03.05.2012). This can be seen in Charlotte's and Alexandre's process. Since the very beginning they asserted that it would not be the end of their life if they could not have children. They say:

> *C: I can see my life, I can imagine my life without children.*
>
> *A: I am not going to commit suicide because I can't have any children!*
>
> *C: No we have a very pleasant life. We travel a lot, we don't deny ourselves anything, we share a lot of activities, and finally we spend a lot of time together, because we work together, so we don't need this to fulfil something perhaps (Charlotte and Alexandre, 20.05.2011).*

There is a constant tension or ambivalence between the wish for a child, the continuing treatment, as it will bring happiness, somebody to pass on values to, and who will be there when older, and the acknowledgement that one's own life is very good indeed, besides the fact of lacking children. "We cannot complain" Charlotte keeps repeating, "we have a very good life". In

Charlotte's case, age intervenes by means of a non-renewable reproductive substance. For example, she says that she has to "accept that her oocytes are too old now". She is especially stressed by the ineluctable aspect of reproductive aging, in contrast with the time Alexandre has ahead:

> *Well, I think, me regarding my age, I know that in 2-3 years, there will be no hope at all. Even before in fact, I will stop when we will be done with the remaining transfers. But Alexandre, he is still young and in spite of everything, he will still be able to, well I am not sure we will be together in ten years' time. He will always have the possibility of having a child, but me, I won't have it at all. Well me, the irreversible side stresses me. Because I am reaching my last cartridge. I am reaching this stage. So, it is… well. On the other side, I am also happy to finish with all that stuff, because I am clearly tired with all this treatment. So I am really reaching the end (Charlotte and Alexandre, 20.05.2011).*

Thinking about the end of ARTs emerges as the result of the amount of linear time spent since the beginning of treatment and as the exhaustion of hope. Charlotte is looking for a way out of the endless repetition of treatment cycles taking over her life and preventing her from investing energy in other professional and personal projects. She experiences the negative result following the last transfer as an extremely painful event. She tells me how they gave her a medical file, which she found so thick. She kept looking at it, holding it in her hands, as the materialization of the efforts, the money, the hope, the time spent trying to have a child, and which was the only thing remaining from treatment. The medical file was the last material trace of six years of treatment without any success. It materialized the time spent, and the lack of children, the failure, in spite of all their efforts. That day, she cried a lot and stayed inside. When we meet later, she tells me that they went to Spain after this episode. She did not want to start a third IVF and did not want to turn to egg donation, but Alexandre wanted to continue and she wanted to be confirmed in her decision that there was no hope any more. They took an appointment in a clinic recommended by their doctor to have another medical opinion. They underwent other examinations and no real additional causes were found. Even though the Spanish clinicians proposed to start a third IVF Charlotte stood firm on her decision not to go on with ARTs.

Here the right time to end treatment is the result of a complex choreographing of different elements, where age is the exhaustion of reproductive substance after years spent in reproductive treatment, but works also as a legitimate reason to give up after all these years. The duration of the treatment combined with the exhaustion of hope aligned with the age-related exhaustion of gametes legitimates the right to dedicate money and energy to herself and her projects. The last

time I saw her, she announced that they were breaking up, and that she was moving soon to a new smaller apartment in the city centre. When I asked her about the possibility of having a child with a new partner, she answered that it was not in her plans, but that she kept the possibility open. So even though the story seems to have reached an end, there is still a possibility that in a new couple relationship, this configuration may take another shape.

Intermediary remarks

This chapter has explored several facets of the temporalities of ARTs. While age and time are intuitively very connected, to the point that one can be taken for the other, their relationship remains often unspecified, and this chapter has tried to highlight several aspects of this by focusing on patients' experiences. It has especially documented how the conflicting temporalities characterizing ARTs and the efforts of patients to calibrate them generate the reality of biological age and chronological age, as both linear and irreversible. On the one hand, it has shown how "potential age-related infertility" and the awareness of the age-related fertility decline play a crucial role in determining the timing of having children and how the materialization of age in the clinic reinforces the sense of urgency towards linear time passing. On the other hand, it has shown how biological age becomes so important because of the specific temporality of treatment cycles so that one has to live with a "calendar in the mind" and which is characterized by wait, cyclical time, and a stretched sense of time.

While age can be chronological, biological, and statistical, as shown in the previous chapters, this chapter has shown how age is also a matter of time, and how the specific temporality of reproductive treatment works as an apparatus by which the different versions combine, and age comes to matter greatly. The previous chapter focused on the technical and material aspects contributing to the materialization of age, but also highlighted how age emerges as a resisting force through treatment. This chapter has gone further in highlighting how time plays a crucial role in the apparatuses of reproductive treatment cycles and contributes to generating the sense of reality of age-related infertility. In other words, the materiality of age and time are co-produced along with reproductive treatment and while time goes beyond the question of age, it is an essential aspect of the "ontological choreography" (Thompson 2005) of reproductive aging.

The next chapter will continue with the exploration of patients' experiences in order to understand how the nature of age is negotiated and transformed when women turn to egg donation. While reproductive medicine treatments work as an apparatus producing the reality of

the age-related fertility decline, it also provides the means to disturb and transform the linearity of age.

8. Aging eggs, ageless mothers?

Originally from Switzerland, Jessica worked for years as a medical assistant in ARTs clinics in Spain. She had recently returned to her country and was looking for a new job when I met her. I discovered her work and contacted her through a website providing support and accompaniment services to ARTs patients turning to clinics abroad in order to have a child. She started our discussion by making clear that the website was closed and that she was not providing this kind of services in exchange for money, but only to help friends. Having worked in one of the European platforms for egg donation programs, as shown by the statistics of the Catalonia register in Spain (Bosser et al. 2009; see also Bühler 2014a), she expressed repeatedly how restricted, fearful, and even inhuman she found the situation of ARTs in Switzerland, "where everything is prohibited" (Jessica, 27.06.11), in contrast with the situation in Spain.

During the interview, Jessica frequently insisted on the beauty of the altruistic gesture of donating oocytes and on the liberating dimension of using donated eggs for women whom she described as "not having any man, or woman in their lives, knowing exactly what they want, who travel, who are intelligent, who speak several languages" and that she was most impressed by. Interestingly, aging oocytes were not presented as the main obstacle to the success of ARTs, similarly to what I had noticed in interviews with Swiss clinicians and patients, but the endometrium was the most difficult part to handle for her: "We don't need tubes. We don't need oocytes [from the patient]. But without a good endometrium, we cannot do anything" (Jessica 17.06.2011). The way aging oocytes were not presented as a problematic part in the success of IVF caught my attention, because it illustrates how when the replacement of oocytes is a normalized part of treatment, it does not matter as much, than when it is prohibited.

After the interview was over, we kept discussing the topic as we walked together to the train station. As it became more personal, I asked Jessica about her own desire for a child. To my great surprise, while she was already over 40, she said that she was not sure of really wanting a child, but that she felt she had still ten good years ahead in order for her to make a decision. Her apparently unfeigned quietness towards the possibility of becoming a mother after forty contrasted strongly with the importance that reproductive aging and age limits took in the trajectories of people turning to ARTs in Switzerland as shown in the two previous chapters. She did not mean that there was no biological end to fertility. She did not say that she had not envisioned any age limits to childbearing, but the forties seemed simply for her a period of time when having children with donated oocytes was easy and completely self-evident. Stressing that

for her the genetic component of motherhood did not matter at all, contrarily to the carrying of the pregnancy, it sounded as if there was no difference between her own oocytes and those provided by a donor and that the extension of fertility time, up to the beginning of her fifties, was something fully normal.

This moment of my fieldwork drew my attention to the working of egg donation as an anti-aging technology by extending the limits of fertility and consequently of motherhood, not only for postmenopausal women, but for women in their late thirties and forties, likely to face age-related infertility. What made me think is that before actually turning to the procedure, the knowledge of this possibility had an impact on the way Jessica understood the scope of her reproductive possibilities. The idea that the spread of ARTs, as all-powerful to help women to have a child at any age, induces a false idea about women's reproductive options, and encourage them to delay childbearing is present in public discourses on late motherhood and postmenopausal pregnancies. It is even part of the oversimplified public explanation that women postpone childbearing because of a triple denial of age – sociological, biological and anthropological – encouraged by the belief in the power of ARTs to work as a technological fix (Bessin and Levilain 2012).

However, in Switzerland, the use of ARTs by postmenopausal women has caused public controversy and postmenopausal pregnancy cases have made major headlines in an ambivalent mixture of admiration for age records and moral disapproval. Swiss newspapers express concern about late motherhood as highly problematic and even as a national problem, as one can read in the daily newspaper 24H title "Switzerland without answer to late pregnancies"[89] (Mayencourt 2012) in reaction to the case of a 66 year-old woman having given birth to twins. These comments rather than inscribing the extension of fertility in a utopian future where women would have more control on their biology, or praising ARTs as a technological fix solving the so-called problematic reconciliation between career and family, put rather in the foreground the abnormal and threatening dimension of these extraordinary pregnancies (Bühler 2015). At the core of these debates is the idea that by enabling the extension of female fertility, some ARTs – ova donation and more recently egg freezing – may transform the experience of age-related infertility. Its transformation from a structuring element, separating the fertile and infertile phases of women's lives, into an element that can be submitted to a choice, and even encourage women to postpone motherhood with the idea that ARTs will help them is considered with suspicion and mistrust. In addition, this transformation is feared to have all kinds of bad social and medical consequences.

[89] Translated by the author. Original title: "La Suisse sans réponse face aux grossesses tardives".

This chapter is about how the choice to turn to egg donation transforms the ways women in their forties think about the nature of the age-related fertility decline. While the two previous chapters have highlighted how age materializes in reproductive medicine practices through several apparatuses such as the testing of the ovarian reserve and statistics, they have also shown how age emerges as a resisting force to ARTs treatments, and as a matter of time. Multiple versions of age – chronological, biological, statistical, and temporal – have been identified and differences highlighted. However, the previous chapter has shown how in the clinic the versions tend to articulate in a way that reinforces the salience of the linearity and ineluctability of chronological and biological times. In contrast, this chapter explores how the entry into play of egg donation, that is prohibited in Switzerland, transforms the "ontological choreography" (Thompson 2005) of reproductive aging. It focuses especially on the redistribution of agency and in the "naturalization" and "normalization" (de Jong 2009; Thompson 2005) processes at stake in the choice to turn to egg donation and on their impact on the "nature" of reproductive aging. I start by presenting literature on choice, agency, and nature, and then explore in depth two trajectories of women turning to egg donation over forty.

8.1. Choosing technology, transforming nature?

The issue of choice is problematized in literature on anti-aging medicine and technologies, where the potential of avoiding death and prolonging life biotechnologically leads to a "tyranny of potential" (Kaufman 2013), that is, the moral obligation to take action, which affects individual subjectivity, citizenship, access and belonging. The concept of "reflexive longevity" (Kaufman and Fjord 2011) has been coined to characterize the government of time in Western aging societies, that "instantiates a relentless naturalized future-thinking about life itself, in which longevity has become an object of biotechnical intervention and a personal responsibility" (Kaufman and Fjord 2011: 218). The way biogerontology transforms aging into a risk category (Rose 2001), matter of individual responsibility and consumption leads to "a situation in which the prudent does not need it, while the imprudent does not deserve it, ignoring the fact that it is the resource rich who can afford this investment in self-care" (Cardona 2008: 477). It has been criticized as reinforcing ageism (Vincent 2006; Vincent 2008) and social inequalities (Cardona 2008), but also more positively valued as contributing to the social inclusion of older people (Latimer et al. 2011).

In the context of ARTs, similar reflections on the matter of choice have been discussed. In *Embodied Progress*, Franklin (1997) asks how IVF becomes a desirable solution. Her analysis of

narratives of women undergoing IVF in the context of the Thatcherite enterprise culture shows how "reproductive freedom is redefined as consumer choice and customer satisfaction" (1997: 163). Underlying the "double-edged" character of IVF, Franklin shows how choice for ARTs is made, at the same time that it is described as inevitable (1997: 169). To undergo ARTs may not bring the desired child, but should provide a resolution to the uncertainty produced by infertility and give the satisfaction of having tried everything possible. Echoing the concept of the "tyranny of potential" (Kaufman 2013), the concept of "prescriptive fertility", proposed by Strathern (1992b), is useful for understanding this process: "There is the question of prescriptive fertility, for instance, that accompanies what one could call prescriptive consumerism, namely the idea that if you have the opportunity to enhance yourself you should take it" (1992b: 36). Stressing how procreation can be thought of as subject of choice and personal preference in an unprecedented way, Strathern describes how choice becomes the central feature used to differentiate the having and not-having of children: "The sense that one has no choice not to consume is a version of the feeling that one has no choice not to make a choice. Choice is imagined as the only source of difference" (Strathern 1992b: 37). In this context, what the child reproduces and embodies is the parental choice and desire to have a child (Strathern 1992b: 32).

Reflections about choice lead us to think about what is considered as determined and as open to change in people's lives. Indeed, in a consumer cultural model "human beings are enterprising creatures who "construct" and make what they will "out of" the givens of existence and environmental constraints" (Strathern 1992b: 37). Following those authors, I think that the way in which the choice to turn to egg donation in order to extend fertility is made and thought about can teach us much about "nature and culture" merographic connections (Strathern 1992a) and their associated passive and active dimensions. Historically in western thinking, nature has been framed as the domain of the given, of passivity, of what exists universally independently of human and cultural intervention. Culture, in contrast has been framed as the domain of the made, of human choice and difference (e.g. Descola and Pálsson 1996; Viveiros de Castro 1998). Therefore it is interesting to look at the transformations and redistribution of agency operating when something supposedly belonging to the domain of nature, becomes an object of choice, and consequently of culture.

The concepts of naturalisation and normalisation coined by Thompson (2005) in her extensive study of the ontological choreography of making parents are very useful for thinking about these transformations. The concept of "normalisation" is developed to think about the integration of new elements in the clinic practices:

> *It "[…] includes the means by which "new data" (new patients, new scientific knowledge, new staff members, new instruments, new administrative constraints) are incorporated into pre-existing procedures and objects of the clinic. It also includes the ways in which the grid of what is already there is produced, recognized, reproduced, and changed over time" (Thompson 2005: 80).*

It refers both to the "normal" and the "normative" in reference to Foucault and Goffman. "Naturalisation" refers to "the rendering of states of affairs and facts in a scientific or biological idiom and to the means by which aspects of the site are rendered unproblematic or self-evident in the sense of seeming "natural" " (Thompson 2005: 81). Stressing the variety of registers that can be mobilized in normalisation processes, De Jong proposes:

> *[…] a redefinition of normalisation as a process of making identities, subjectivities, and social relationships self-evident by means of a diverse spectrum of natural, biological, social and religious idioms or rhetorical strategies, in addition to the use of statistics and routines as general practices (de Jong 2009: 37).*

While the two concepts of "normalisation" and "naturalisation" are different, in practice they usually tend to work together as "what is normal is often stabilized by what is natural in this site" and " what is normal or normative also helps fix what is naturalized" (Thompson 2005: 81). According to Thompson, looking at these processes of normalization and naturalization is crucial as it allows us to pay attention to the moral, epistemic, and technical taken-for-granted categories essential to reproductive medicine practices. She further develops the concept of "strategic naturalization" to highlight how both "nature" and "culture" are co-produced and necessary to disambiguate kinship relations in the context of third-party conception (Cussins 1996; see also de Jong 2009; Thompson 2005).

These processes enable patients and clinicians to transform the taken-for-granted, the already there, and to deal with the newness of technological possibilities. Therefore they are useful for thinking about how the nature of reproductive aging might be transformed when it becomes a matter of choice. I propose to examine these processes, not in the clinic, but on a longer term in women's trajectories in turning to egg donation after forty. Highlighting the stakes of women's complex negotiation processes allows the illumination of the role of these naturalisation and normalisation processes in the transformation of the understanding of age-related fertility and related age limits of motherhood. It also allows the complicating of the notion of "choice" underlying discourses about "the right moment" to have a child and the turn to ARTs to do it.

Rather than a free choice, characteristic of liberal ideology, these decisions are constrained by many sociological, ideological, and material components (Van der Sijpt 2014). However, women prove also to have agency and to be actively choreographing the conditions of their having a child, as shown in an exemplary way by Charis Thompson (Cussins 1996; Thompson 2005).

Often absent from these public discourses are the voices of the actual women who turn to egg donation when they meet difficulties in having a child due to their age. If postmenopausal mothers can express their opinion publicly, as part of the sensational media coverage of their cases (e.g. Bauman 2010a; David 2010b), the silent majority of perimenopausal women going abroad to access the procedure remains unheard[90], with the exception of the two extensive and remarkable studies by Friese, Becker and Nachtigall (2006 and 2008) on the experiences and meanings of older mothers through egg donation in the US. Their second study, especially, sheds light on the ambivalent anti-aging dimension of egg donation as both enabling the extension of female fertility, possibly beyond the menopause, and as troubling the strong association between youth and fertility (Löwy 2006; Löwy 2009), but also on the limits of the decoupling of age and fertility, as age is still experienced as a stigma, or as the visible sign of the turn to egg donation.

Following these authors, I would like to examine the anti-aging dimension of egg donation, less from a technical level – which is the targeting and replacement of the aging oocytes and has been explored in chapter 4 – than from the level of the women themselves by analysing their negotiations and strategies to normalise and naturalise (de Jong 2009; Thompson 2005) "the crossing over of a 'natural' boundary" (Pridmore-Brown 2009: 82). I wonder how and under what conditions, the choice to turn to egg donation is made and what are the effects of this choice on the experience and meaning of reproductive aging and the associated age limit of motherhood. In other words I am interested in exploring how the nature of reproductive aging is transformed when the choice to turn to egg donation is made.

By examining in detail the two trajectories of Valérie and Danièle, both turning to egg donation to have a child, I will show how they de-essentialize chronological and biological age by stressing the importance of an "inner age" and "ageless self"[91] (Kaufman 1994). I selected them because

[90] Based on data collected by the Federal Office of Statistics (OFS) on the number of live birth according to mother's age, we can see that the number of mothers between 45 and 50 years old shifted from 54 in 1982 (out of a total of 74 916 live birth) to 324 in 2012 (out of 82 164 live births) and that the number of mothers over 50 years old shifted from 0 in 1982 to 14 in 2012. However, egg donation is not taken into account in statistics on assisted reproductive medicine and its extent is difficult to quantify.

[91] Kaufman uses the concept of the « ageless self » to designate "an identity that maintains continuity despite the physical and social changes to come with old age" (Kaufman 1994 : 7). It describes the way older people draw on the past as a resource for being in the present. It is ongoing, continuous, and creative. While her study focuses on older people, I think that it reflects well the sense of "agelessness" expressed by the women in my study, in the sense of a core identity or inner self, that would stay untouched by chronological or biological age.

they decided to have a child after forty, which makes their decision-making process revealing of the ambivalence at stake in having a child through egg donation in the forties, but also of the normalisation and naturalisation strategies mobilized to legitimize their choices. I met them both through an Internet forum dedicated to motherhood and family issues where I posted a call for participants in my research. I met them three times: the first time before they went to Spain to undergo the procedure, the second time when they were pregnant, and the third time with their respective children. During the time of my fieldwork, I stayed in touch with both of them, through emails. I also consulted Valérie's blog[92] on a regular basis. I will start with Valérie's trajectory. Examining how she speaks about her own decision to have a child and to turn to egg donation enables us to grasp the interplay of agency and determining factors, as well as to complicate the vision of women "choosing" rationally to have a child when older. Then I will turn to Danièle, who develops a specific understanding of age that goes beyond the decoupling of chronological age and biological age.

8.2. Valérie or choosing while not choosing

8.2.1. "I DID NOT WANT CHILDREN"

Valérie is 42 when I meet her for the first time in the comfortable but busy atmosphere of the café of an international Hotel, bathed in the background noise of soft music, the coming and goings of people, and vibrant conversations. She starts our discussion by explaining to me how she has come to the decision of trying to have a child. She says that she undertook prolonged university studies and that she started to work late in her life in comparison with people who do not study. Traumatized by her childhood with a stay-at-home mother totally unsuited for that ("à qui cela ne convenait pas du tout")[93], it was most important for her to develop professionally in order to avoid the reproduction of this maternal model. In her early thirties, she was in a stable relationship and had started to make plans for marrying and creating a family, but her partner split up abruptly from her, putting a painful end to those mutual emerging projects.

About the phase of her life that followed the separation, Valérie says that she put much energy into her work, which was very rewarding at many levels. She earned good money, had success, a good circle of friends and colleagues without children. In short she enjoyed a great life. About the "project for a baby", she says that she had abandoned the idea. She did not want to be like her own mother. Her close circle was accustomed to the idea that she would not have any children.

[92] https://lepetitmiracle.wordpress.com/ - accessed on December 20, 2015.
[93] The parts of sentence in quotation marks are taken from the interviews and are Valérie's words, translated by the author.

She did not feel any need or desire for a child and was happy with her life the way it was. In addition and confirming her decision, for her being in a stable relationship with a reliable partner was an inescapable prerequisite to the creation of a family, which did not occur during this period of time. This "assumed choice" was part of her self to the extent that when she met her current partner at the age of 37, she announced up-front that she would stay childless. Her partner, seven years younger – an age difference that she describes as a large gap – did want to have children one day in the future, but respected her decision.

However, several elements made her change her mind about not having children. First of all, she lost her job due the corporate overhaul of her company. She stayed unemployed for many months and when she finally found a new job, she experienced harassment that lead her to experience burn-out. She then started psychotherapy that made her question her decision to stay childless. Through the psychotherapy, this choice became reinterpreted as the fear of repeating the problems of her mother and her own suffering as a child. Reaching forty, the psychotherapy also lead her to review her own life ("faire un bilan de sa vie") and realize that she actually did want things to change. Her partner whom she described as having very different values than the people she used to spend time with, also made her catch a glimpse of another kind of life. She describes him as her opposite, that is more relational, emotional and not interested in money, success, or appearances. The combination of these several factors lead her to ask "what is the essence of life", "what is really important", and "what she wanted to transmit and share". This existential crisis entailed a rethinking and reformulation of her previous reproductive decision, as she expresses: "What was an assumed choice, was not necessarily one *a posteriori*".

Once she decided with her partner that they wanted to have a child, then came the question of the "right moment". She was still in a precarious professional situation and he did not earn enough money for the two of them. In addition, besides the financial aspect of the question, she was afraid of not being able to choose to stay at home or to work if she wanted to, once the baby was born, as she did not have a permanent position. Reaching 42 years old, she felt that it was the last moment to make up her mind. She says:

> *V: Life goes on ("la roue tourne"), age passes, and there is a moment when one has to say that one must renounce the idea of the ideal moment.*
>
> *NB: Under pressure from the biological?*
>
> *V: Yes and the psychological (Valérie, 7.10.2011).*

What this narrative shows is that the idea of an active choice – to stay childless – is dependent on specific conditions, and that when these conditions change the initial choice is reframed as a non-choice. This initial "assumed choice" becomes a choice determined by external factors, mainly a difficult childhood with a mother who was not well psychically. It then transforms into another active choice – to have a child – that remains open to further reinterpretation later in life. Therefore the idea of choice itself becomes a narrative illusion as it is impossible to disentangle what is her "true choice" from the multiple elements – external and internal – determining it. In her narrative, there is the idea that there was an inner desire for a child that could not be expressed because of the fear of repeating maternal schemes, but as she makes clear, in her thirties she felt really deeply and with certainty that she did not want a child. In this sense, the inner "true" decision is the result of a personal negotiation with oneself and of the retrospective narrative making the previous "assumed" choices appear as disguised and untrue.

This moment also shows how closely interwoven are the different elements underlying the decision to have a child – professional, relational, financial, psychological, and biological – and how the biological on its own is not enough to make her decide that it is the right moment, but is also a necessary condition of her abandoning the normative ideal of the "right moment". When I meet her for the second time, at the end of her pregnancy, she insists a lot that biology was not the prevailing factor in her decision to have a child:

> *It is not the age limit that pushed me to do it now. I did it because I felt that it was the right moment. Of course, it was not good to wait too much, but if I had not felt this need, well I would not have had a child. For twenty years I thought that I would not have children, so something was needed in order for me to change my mind, and think that I did not want to miss this experience (Valérie, 12.07.2012).*

Without denying that the age-related decline of fertility played a role in her decision to have a child, she stresses that the inner feeling of "being ready" was the most determining factor. She adds:

> *It [chronological age] was not of specific concern. For me what matters is to feel good as one is. I know that until 25, or 35, I would not have been so open and ready as I am now to welcome this state of motherhood. So I don't regret. Not at all. I will be a much better mom now than I would have been at 25 (Valérie, 12.07.2012).*

By insisting on the importance of "feeling ready" as the justification of the right moment to have a child, she individualizes and psychologizes age. To some extent, the right moment to have a

child is independent from her chronological and biological ages. In this way, she adds another dimension to this initial decoupling of the biological and the chronological, that is an inner age reflecting how she feels inside. However, it is important to notice that the insistence on the inner age or the "ageless self" (Kaufman 1994) comes only when she is actually pregnant thanks to egg donation and that the importance of biological age is diminished as she is able to carry a pregnancy and thus to have a child. As a consequence, the importance of biological age or of an inner age, in the determination of reproductive choices is highly dependent on the result of ART's treatments and can only be distinguished in an *a posteriori* narrative. Following her logic, I then ask her if the happening of this "readiness feeling" might occur at any age or whether some age limits to motherhood are desirable. She answers:

> *It is hard to answer. I think that if this feeling had appeared at 50 I would have said no. It is a little difficult for me to understand these 60, 70 year-old women. Technically, nowadays, it is possible, but there are nevertheless some… it is easy to say, because it won't concern myself, but I don't think I would have… Now I feel young, I am still young. I have a life expectancy that is still relatively long. So I should be able to enjoy life with my child. If one is 60 or 70 years old, then I think that one approaches a dangerous limit, because one makes potential orphans ("orphelins en puissance"). For me, the fact that the dad is younger, he is 36 now, it improves the balance a little bit (Valérie, 12.07.2012).*

We can read in this interview excerpt that even though there might be a technical possibility of extending female fertility until aged sixty or seventy, Valérie does not think that it is desirable to go to this extent. Rather than promoting an absolute decoupling of age and fertility, she thinks that motherhood should include age limits, neither based on the biology of reproductive aging, nor based on chronological age either, but on the individual's life expectancy with the idea that one should enjoy life with one's child and be able to raise him or her in order not to make potential orphans, that is, in the name of the child's wellbeing. While the importance of "feeling ready" as an inner age component is potentially leading to an endless postponing of age limits, and is actually used by some postmenopausal women to legitimize their choice (David 2010b), another logic, of intergenerational care, is mobilized here in order to justify the setting of age limits. Furthermore, by distinguishing her own case from the postmenopausal pregnancy cases, Valérie, still at the beginning of her forties, normalizes and legitimizes her own situation.

8.2.2. DECIDING TO TURN TO EGG DONATION

Giving up on the normatively determined ideal of the "right moment" does not entail that a pregnancy will occur automatically as is often believed when one stops contraception (Szewczuk 2012). Valérie explains that she had stopped taking the pill two years before deciding that she really wanted a child. She was not worried about not being pregnant because she and her partner were not doing anything special to optimize the occurrence of a conception. However, on her 42th birthday, she experienced a greater awareness that the "biological clock" was ticking and that it might be the last moment to raise seriously the question of a child. She then decided to consult her gynaecologist in order to check that everything was all right. The doctor saw her and gave her recommendations about how to "do things in a more directed way", which meant by targeting the right moment in the menstrual cycle in order to optimize the chance of conception. But Valérie asked for more medical investigations, as she explains:

> *I am 42, after all. I would like to be provided with a more accurate picture than just hearing, "let's try again". I am not stupid, I know what fertility is. I was expecting that I would be told that it was not really possible, or that naturally it was not going to be easy. What I was not expecting is… I imagined that ARTs could do many things, and that even with an aging body, or at least aging oocytes, it was nevertheless possible to sort out embryos to ensure pregnancy, which is actually not the case. So, I was monitored on my June cycle, we did really all the exams. Hormonal levels were not very good, other results not better. And then the gynaecologist told me that the solution for me was egg donation, and I was like, no, it is not possible! And then I got pregnant naturally, because we had done it at the right moment. And I was like: "What are these doctors saying, they talk rubbish, egg donation? This is a nonsense, this is rubbish!". And it kept going during a month and a half, and then I miscarried. […] After that I started to look for more information. I had heard about miscarriages, that risk was increased, but in my mind, I was just thinking: "Great, I can get pregnant, there is no reason it is not going to work", but after the miscarriage I started to question it again (Valérie, 07.10.2011).*

The description of this moment in her trajectory shows the oscillation between different ontologies of reproductive aging. During the first part of her life, when she did not want a child, age did not matter. It is only when the desire for a child was asserted, that age, or the possibility that she might have "aging oocytes" started to be important for her. On the one hand, she was aware that fertility declines with age. When she says that she is not stupid, she is referring to a taken-for-granted common knowledge in the sense of facts of life that everybody knows. But on the other hand, she knew that her chronological age might not reflect the state of her fertility

potential and she turned to the gynaecologist with the demand for a "more accurate picture" of her chances and of what might go wrong.

In this moment of uncertainty, she is neither sure about the extent of reproductive aging and whether her fertility might be already affected by it, nor about the potential of ARTs to act on it. She expects that at her age it will be more difficult to conceive, but not that ARTs cannot do anything about it. It is the suggestion of the gynaecologist that Valérie should turn to egg donation that confirms roughly that she has "aging oocytes" and that ARTs are powerless to help her without the oocytes of a younger donor. It is important to notice that egg donation was not an option she had in mind before consulting her gynaecologist. She did not know more about reproductive medicine and reproductive aging than what can be heard in the media and public discourses. She had the vague idea that a selection of the better embryos was possible and that it might help when older, but did not think of replacing her oocytes with those provided by a younger donor.

However, the initial confirmation that her oocytes are already "too old" proves to be wrong. In fact, contradicting medical predictions, she gets pregnant just by scheduling the most optimal moment for conception, confirming positively that it is not too late to have a child with her own oocytes. In this moment, she feels empowered and finds all the medical discourses "rubbish". But after a month and a half she suffers a miscarriage. The loss of the happiness produced by the positive pregnancy test materializes painfully age-related infertility, and the fact that her chances of getting pregnant might be reduced. It works also as a recall that the problem with "aging oocytes" is not only that a pregnancy might be more difficult to obtain, but that it is also more difficult to keep. She starts reading information on the Internet and becomes aware that getting pregnant is only one part of the process. She says:

> *One hears about miscarriages, that the risk increases, but in my mind it was: "Great!! I can get pregnant, so there is no reason that is does not work". But after the miscarriage I started to question all this (Valérie, 07.10.2011).*

The description of this moment in Valérie's trajectory shows in an exemplary way the uncertainty about the effects of reproductive aging on fertility and about the role ARTs might play in her getting pregnant. She does not have a clear idea about her chances of getting pregnant and even less about keeping the pregnancy. It is only through the medical recommendation to turn to egg donation, and through her miscarriage, that the sentiment that it is already "too late" in regards to

the biology of reproductive aging, emerges and transforms from a vague awareness into a stronger certainty. In this sense, egg donation produces both the biological limits of fertility, as it confirms that her ovarian reserve is already too depleted and their decoupling from the age limits of motherhood, as it allows possibly carrying a child. It is only through the miscarriage and the medical recommendation to turn to egg donation that reproductive aging "gets real" (see also chapter 6 about the "getting real" of age-related infertility), and that it becomes something tangible than can be circumvented. In other words, Valérie's case confirms that the materialization of reproductive aging in "old eggs" is a condition of possibility for egg donation to work as an anti-aging technology (see Chapter 4 about the making of "old eggs").

Facing the age-related fertility decline is hard for Valérie, but the possibility of turning to egg donation gives her hope in that it does not signify the age limit of motherhood. However turning to this procedure, while she never anticipated it, turns out to be a complicated decision, as one can observe in the following explanation:

> *We underwent the whole battery of standard tests: spermiogram, hormonal levels. And she [a reproductive medicine practitioner] immediately evoked egg donation because she said: "You can get pregnant naturally, but the chance that it hangs on…". She presented many statistics. A priori I have 5% chance to get pregnant naturally, and with my age, only 2 to 3%. That makes 2 to 3% out of 5%. And it needs to stay, to stick, because among these embryos, there will be some which will have some defects, because the oocyte's quality is bad, they can have malformation problems. So then I started to put everything in question. Did I really want to go through again?… I mean the miscarriage risk will always be there, but here it is really more pronounced. In addition, the risk of having an unhealthy child, who is not viable, it is always a risk, but one would prefer him to be healthy. It made me think. To undergo IVF, it is a heavy treatment, it is exhausting, it is expensive in Switzerland because there is no reimbursement. And then will it be useful? It can work, but not more than a natural pregnancy, finally. Because the embryo will not be of better quality. […] It is not only stats, even though stats matter a lot, it is also, if reproductive medicine could help to sort out the embryos which do not have genetic problems, then well maybe we would attempt the adventure. But just with IVF we won't have any more advantage than with the natural method. Of course we can go on, but we have to accept the consequences: multiple miscarriage. First, I have to get pregnant again, we have tried up to today naturally and after the miscarriage it never occurred again, well it has only been two months, but it does not come back as easily as the first time, maybe it was just a stroke of good fortune, we do not know, it is nature. Shall we keep going naturally, and what will be will be? But we know that chances are so reduced. They are not non-existent, but so reduced (Valérie, 07.10.2011).*

In this interview excerpt, the way in which Valérie presents her decision to turn to egg donation is framed as a rational choice between three options: keeping on trying to conceive without any medical assistance, IVF with her own oocytes, and IVF with those of a younger donor. She weighs carefully the benefits and risks of the options available to her as a calculation between the emotional, financial, and health costs and the benefits sought. In this moment of decision-making, age becomes a crucial turning point where statistics become eloquent enough to make her choose between different treatment options. If "IVF only", as Valérie says, does not offer better chances of having a healthy child than without medical assistance, then it loses its attraction. Why turn to reproductive medicine, if it does not offer better chances than "natural" conception? Valérie in effect is asking.

The role of statistics in the difficulty, or even impossibility, of stopping ARTs treatment has been well highlighted by Thompson (2005) and has already been discussed in the previous chapter, but I would like to point to their specific use in Valérie's decision to turn to egg donation. Here, less than the statistical probability that a small chance might increase the chances of conception, giving hope and encouraging her to continue, statistics are used to rationalize a difficult and emotional decision. The combination of the statistics displaying age-related reduced chance of getting pregnant and statistics displaying age-related increased risk of having miscarriages, clearly makes the balance tilt in favour of egg donation. While for Valérie the renouncement of the opportunity to pass on her genes raises many difficult and emotional questions and doubts over the anonymity of the donor, the need for resemblance, and the possible disclosure of the procedure, setting the priority of having a healthy child over the one of having a genetically related one, as in "IVF only", helps her to make up her mind. In the confusion of this moment of decision, where the fear of suffering another miscarriage and of giving up on the transmission of her genes prevails, statistics work to rationalize her decision by the contrast between figures, which is eloquent from a "rational point of view" as she says.

However, the embodied and very material experience of going through a miscarriage is also part of Valérie's decision. In spite of the very rational dimension of her decision, drawing on the statistical chances of having a healthy child with one or the other option, statistics are not enough to make the balance definitely tilt in favour of one or the other. In her decision-making, statistics are not just figures associated with the probability of some event happening and comprising a degree of uncertainty, they are also her very embodied, painful and concrete experience of miscarrying. The perspective of going through it multiple times, as statistics would suggest, is not an option for her. However, even though risk materializes in this experience, uncertainties

remain, and to know whether she "gave up" too quickly or took the "right decision" remains a nagging question, as one can read in the following quotation:

> *Am I renouncing too quickly? Shall I try preliminary treatment here? Because, of course, we are told that there are few chances, but there are still some. […] Am I giving up too quickly? Did I listen too much to traditional medicine [biomedicine], while Chinese medicine says it might help? Shall I consult other therapists? […] It is true that we are facing a broad spectrum of choices… How far shall we go? How far is too far or not enough? (Valérie, 07.10.2011).*

Indeed, in spite of the very rational dimension of her decision, statistics on age-related infertility produce an uncertainty zone, where the effect of age becomes on the one hand, extremely concrete and embodied, but on the other, always hypothetical, in the sense that statistics never say on which side people will stand. In this sense, statistics are used to render the decision to turn to egg donation, an unanticipated option, less emotional and helps to prioritize what is the most important element for her in having a child, but also produces uncertainties, and especially will never respond to the doubt about the "right moment" to renounce transmitting her own genes. While this doubt is uncomfortable, one can also say that it drives her to take a decision, as it is in a dynamic relationship with future hopes, as expressed by Brown about the regimes of truth and hope in science: "the uncertainties of present doubt and the potential for future certainty or truths are in dynamic relationship with one another, that is the present absence of certainty is itself constitutive of the hope for, and drive toward, future truth" (Brown 2005: 333).[94]

The sense that she does not have enough time, because of her age and of time passing, to test other therapies helps her to reach a decision. In addition to the statistically driven decision to turn to egg donation, she is also very aware of the amount of resources – financial, psychological, and physical – needed for each procedure, as she says:

> *I thought that we could try a natural IVF, well traditional, because some selection is still possible, but there are traumatizing treatments. If it does not work, one has to deal with failure. By doing one or two IVF attempts like this, does one not lose?... There are also women who renounce totally. And me, I don't know if I will have the courage to go through all these steps. There are women who have tried for ten years,*

[94] It has to be noted that among the several options she thought of, adopting a child was also included, but the length and the slowness of the administrative procedure discouraged her. She explained that she did not want to be too old when having a child, that she was apparently already too old, and that it was not an option for her to wait for more years before being able to adopt a child. In addition, she mentioned that at the time the procedure would come to an end she would not be able to have a young child due to a legal requirement of a maximal age difference between parents and children. Without any biological reasons, the regulation on adoption seems thus to be more restrictive regarding age than egg donation, that ends up representing a good intermediate option for her, as she will carry the child.

I don't think I could do that. I think that, assuming I have realistic chances, if after two or three times, it does not work, I will think that it won't work and we should rather quit. Anyway, I am too old for that, but I admire some women who hang on and end up succeeding! But they put so much energy into it, their whole existence evolves around this, and I don't want to repeat the mistake of focusing my whole life on only one thing. I want to put my energy into a path that can give, that at least statistically gives chances of working. I think it is worth to at least try (Valérie, 07.10.2011).

Valérie describes very well the culture of perseverance (Franklin 1997) characterizing reproductive medicine. However, instead of being one more step in the course for a baby "at any price", her decision to turn to egg donation is rather an attempt to resist this culture. While she could try to have a first child with her genetic material, she is very much aware that she has not enough time, energy, money, and hope, to spend on a procedure that has so few chances of succeeding. In contrast, egg donation appears as a better solution, as the burden of the medical procedure is shared with a younger donor, and as it promises better chances of success. This decision is also to be understood in the specific context of Switzerland, where IVF costs are not reimbursed. Indeed, later in the discussion, she mentions that if IVF was reimbursed, she would probably have tried a "natural IVF" as she says, just to be sure that she "did not give up too early" and has no regret.

8.2.3. AMBIGUOUS NATURALISATION

By deciding to turn to egg donation, Valérie renders the biological limits of fertility a non-determining factor in her becoming a mother. In other words, she draws on the decoupling of biological or ovarian age and chronological age to extend the age limit of motherhood. Ovarian aging is determining her decision to turn to egg donation, but it does not determine her becoming a mother. Therefore the question of the nature of age limits becomes something ambiguous for her. During our first meeting, she criticizes a lot those celebrities in their forties who have children through egg donation, but do not disclose it thus leading to the public's assumption that they got pregnant without medical assistance. She says:

But it is the same with all these celebrities. It is something I wrote about yesterday [on her blog]. They are all pregnant, the radiant forties. It is very nice, but hypocritical, so hypocritical. And dangerous! In the sense that it perpetuates the idea that one can, and then women are told: "No you have to turn to egg donation". But and them? And them? But they too, in all likelihood. […] Well, there is little doubt

that, obviously the Italian extreme cases, well one knows, but one does not realize that most of the forty year-old and over, it is already that [donated eggs]. This is not very often said (Valérie, 07.10.2011).

The alleged deception points exactly to the apparent naturalness of pregnancies in the forties, in this decade when the age-related fertility decline becomes steeper. Instead of a belief in the omnipotence of ARTs to assist older women in extending fertility, it is the belief that these pregnancies are not medically assisted that makes her think it is possible to have children in her forties without any medical help and that produces the feeling of having been mislead, when at 42 her gynaecologist recommends her to turn to egg donation. Her anger echoes the description of the "eleventh-hour moms" (Friese, Becker and Nachtigall 2006) saying that they were badly informed about the age-related fertility decline. However, once she is pregnant, Valérie's attitude toward the "naturality" of pregnancies in the forties changes and several strategies are used to naturalize the use of donated eggs.

To understand her need for naturalisation, it is important to replace her trajectory in the Swiss context where a climate of taboo predominates. To illustrate this climate, she refers to the online forum through which we met. She says that it is almost impossible to speak about the choice and the experience of turning to egg donation, as it risks raising fierce debates and exposing herself to harsh critics. Of course, she says that some people are nicer and more comprehending, especially on the line of discussion dedicated to women undergoing ARTs, but still the atmosphere of the forum does not encourage the disclosure of the procedure. Sensitive to this moral judgment on women turning to egg donation, she contrasts it with what she observed on forums based in other countries, and especially in the UK, where she was able to collect much information. She says:

V: It helps to reassure oneself, to see that one is not the only one to ask this kind of question, to trivialize it, because it is precisely so taboo, nobody speaks about that, to the point that one thinks that it is exceptional, while it is something relatively commonplace.

N: Yes, it helps to normalise this experience.

V: Yes and to take the drama out of it. It is a way [to have a child], different from others, but it is not a drama either (Valérie, 12.07.2012).

One strategy she uses is to diminish the importance of the medical assistance that was necessary to get her pregnant. She says:

I just needed a little boost […] I just had to turn on a little extra help from nature, euh, from medicine (Valérie, 12.07.2012).

Another strategy is to go back to the uncertainty zone about giving up too early on the attempts with her own oocytes. As there was still a possibility for her to get pregnant without medical assistance, even though very low, it is plausible to assume that she was on the right side of the statistics:

A natural pregnancy is not impossible as I got pregnant just before [getting pregnant with donated eggs] and that I had a miscarriage. I got pregnant naturally, so it is not incongruous. And we could have kept on trying, but I was a little bit in a hurry, because of my age, I could not allow myself to repeat attempts 10 000 times (Valérie, 12.07.2012).

The miscarriage that was determinant in her decision to turn to egg donation is here mobilized to naturalize her pregnancy. In addition, no one in her circle of relatives and friends knows that she went to Spain to access the procedure. As she plans to open up about it one day to her daughter, she does not feel the need to speak about it to other people, and is even rather afraid that the view of her child might change once people know she was conceived with donated eggs. This "strategic naturalization" (Thompson 2005) should be understood in relation to the dominant Western kinship model where genes play a major role in the production of continuity between generations (Schneider 1980). But the non-disclosure of the procedure also has an effect on the naturalisation and normalisation of the age limit of motherhood.

In addition, Valérie stresses that she looks young or that in other people's eyes she is young. To illustrate her point, she tells me about an episode with a bank employee with whom she was speaking about having a second child and about the appropriate age difference between children. She said that at her age she should better not wait too long before having the second one, and the employee was very surprised. The employee explained that she thought that Valérie was ten years younger than what she actually is. The importance of feeling young in other people's eyes works here as a reassurance and validation that she is not too old, contrary to her aging oocytes, and that she does not just feel inside that she is the right age, but that she actually is it. Looking young seems to work as an additional strategy used to naturalize the turn to egg donation because of the age-related fertility decline. But maybe more than a strategy, it works as the ultimate confirmation that she is not too old, and that she is actually young enough to have a child, reinforcing in an ambiguous way the strong relationship between youth and fertility (Löwy 2009).

Aware of her own ambivalence, Valérie writes about a person in a similar situation in her blog. This other woman also in her forties turned to egg donation in Spain and had a little boy, but did not tell anybody about the procedure. So far there is no difference between them, as she notices. But this woman gives recommendations about nutrition presenting her case as the proof that these work. Valérie writes:

> *What I find shocking is not to say "eat healthy and you will get pregnant more easily" because it cannot do any harm to eat well, to relax, to exercise, but to present nutrition as THE solution which enabled this woman to become a mother after forty, while one knows that it has nothing to do with it, is to deceive premenopausal women and deny how difficult it is for some women to achieve to become a mom. […] I cannot speak (for now) about it to my close circle, but I would never say that it is easy […] I try not to maintain an idealist and watered down vision of the women's and couple's lives who turn to ARTs. Nothing is simple in this process. It is a daily struggle, and only the outcome, sometimes happy, is worth the attempts (Valérie's blog).*

While naturalising her own pregnancy, she resists the idea that some easy health measure may help women to get pregnant over forty, as well as the idea that ARTs, and especially egg donation, are an easy technological fix. By insisting on the difficulty of ARTs trajectories, she solves her own ambivalence towards the naturalization of egg donation in the forties. People in her close circle may all assume that she got pregnant without medical assistance, perpetuating the idea that it is easy to get pregnant over forty, but by writing her blog and making public – even though staying anonymous – the difficulties, questionings, and doubts that marked her own turn to egg donation, she circulates another version of ARTs treatments, one that is more an "obstacle course" (Franklin 1997) than an easy "technological fix" (Almeling, Radin and Richardson 2014).

8.3. Danièle, when age matters and does not

8.3.1. AGE DOES NOT MATTER, LIFE PROCESS DOES

Danièle is 46 years old, at the time of our first meeting in the café of a small town, where the warmth indoor contrasts pleasantly with the winter weather. She starts our discussion by explaining to me how she has decided to have a child and to turn to egg donation. She tells me that from age twenty to forty she had decided to stay childless for personal reasons related, among others, to her difficult childhood. She was very happy and had a fulfilled life. She especially dedicated her time and energy to her career as an artist, along with her part-time activity in the service sector. Loving children, she spent very good times with her many nieces

and nephews. However, at the age of forty, she met her current husband, who is four years younger than her, through a meeting site on the Internet and this relationship played a crucial role in her change of position about the possibility of having children. Indeed, her partner runs a family company and is an only child entailing that the transmission of the company rests on his shoulders and those of his possible progeny. Therefore, for him the question of having children was very important. For her, it was less important at the beginning of their relationship. She explains that for her, the priority was first to establish a strong relationship and to marry. However, once these steps were accomplished, she realized that she really wanted children around her. She was open about the way this desire would actualize and thought about adopting, or about providing childcare, but the idea of having a child on their own was so important for her husband, that it is the first option the couple explored.

She contacted her gynaecologist for further examination. As she was already 43 the gynaecologist sent her immediately to reproductive medicine practitioners. She explains how her first appointment with reproductive medicine specialists went. The sperm of her partner was found to be "not very good" according to the current standards, but the appointment with the urologist was reassuring and he told them that they had 30% chance of success with IVF. About the diagnostic procedure concerning herself, she explains:

> *I knew I was ovulating, but nothing more. And then we arrive 15 days later and she [the clinician] performs an ultrasound and she says: "This is great, there are many follicles, this goes well, the uterus is good". I come out of her office, thinking "great!" 15 days later we go back to the clinic to receive the results of the blood test, my husband was there with me and there she says: "Well, there is a good news, the blood test is good, there is no problem, BUT it is your age. And then I ask: "But what's wrong with my age?" She answers: "You see…" I was 44, and I say: "Wait, 6 months ago, I was already this age. And we keep talking and she is trying to find arguments to say "No, no, no". And we end up talking about my weight, she calculates my BMI and says: "Yes with your BMI we cannot do it." And I say: "You had this information from the very beginning, why does it come out now? Just tell us if you want to do it, or not." And she answers: "It is dangerous to yourself to embark on a pregnancy". […] Whatever the statistics, we make them speak as we want, but passing from 30% to 1%, it was a tough pill to swallow (Danièle, 13.02.2012).*

This initial moment of diagnostic and access to ARTs is experienced as very hard for Danièle. The initial phase of diagnostic is rather reassuring and gives her hope that she has good chances of having a child. However, at the second appointment, the gynaecologist refuses her access based on her chronological age and associated risks statistics, as well as her body mass index

(BMI). The individualization of the ovarian age entails that only biological parameters seem to matter in reproductive treatment decisions, independently from chronological age. The simple fact that she undergoes the ovarian reserve examination means for Daniele that it determines the next steps of the treatment and that her access to ARTs is possible, since her chronological age is already known and is not sufficient in the first phase to prevent her from access. However, here chronological age comes in by the back door, and is advanced as the main reason preventing the couple from starting reproductive treatment. The apparently reassuring good results about her ovarian reserve make her chronological age appear as an arbitrary and exterior criterion used to refuse her access to treatment in a second phase. After this initial diagnosis period ending with the refusal of the Swiss clinicians to consider her case, the couple turns to a clinic in Spain. First they try an IVF with her own oocytes, but the clinician there recommends stopping treatment because her response to the hormonal stimulation is too low. For Danièle, it is only at this moment materializing the age-related lack of reproductive substance, that she comes to accept that the age-related fertility decline is already too advanced and that she decides to turn to the oocytes provided by a donor.

She describes this first moment as an unexpected "slap in the face" giving her the feeling that she does not have any value for society any more. The confusion between the age of her oocytes, her chronological age, statistics, and age as an arbitrary criterion setting the age limit of access in a given clinic, produces a feeling of incomprehension and injustice in regard to the initial clinician's decision. In contrast, the possibility of trying IVF with her own oocytes and the lack of response to the hormonal stimulation convince her that her biological age might matter more that she first thought, but she feels also more recognized and taken into account in her desire for a child.

While the biology of reproductive aging plays an important role in her turn to egg donation, Danièle goes beyond the distinction between biological and chronological age and develops her own understanding of age. In a general manner, she relativizes the importance of both chronological and biological age. She says:

> *I think that at the present time, in the world we live in, we are in a moving world, and I have the feeling, age is not, for physicians age is a criterion, but for me it is not. For me it is more the idea that you have a road to take. You will do it first without a child because you have something to learn from it, or you will do it with a child because you have to learn something from it. […] I have been living 46 years without children. That is for a reason. And if there is a child now, he will be much happier now in our family than with me before, this is crystal clear! […] And yes I am forty-six on paper, but in my mind, am I*

really this age? I don't know what would happen if suddenly at 55 years old the desire for a child were to come back… (Danièle, 13.02.2012).

In this quotation we can observe how Danièle inscribes her decision to have a child after forty as the result of a life process, of a long personal journey that has lead her to who she is now and made it impossible for her to have a child earlier in life. In contrast with chronological and biological ages that matter for the reproductive medicine practitioners, for her it is the life process that determines the moment when you have a child, and not chronological, nor biological age. For her, age is something external that is reflected by the doctors but that does not reflect her inner state, as one can read in the following quotation:

It is another one who told me first that I was 46. It is the practitioner who said: "You are 46, we cannot do anything for you". "How is it possible that you cannot do anything for me? In these days you cannot do anything?" It is really the other who reflects age. It is not how I feel (Danièle, 25.06.2012).

She insists that before forty the idea of a child itself was impossible to think about. Rather than a rational decision, she inscribes it at an existential level, as a journey she had to undergo personally and that lead her to this unanticipated decision to have a child after forty. She legitimizes this decision by the happiness of the child-to-be, proportional to her feeling well. For her, forty represents the age at which she "started to live", the "age at which she could finally be herself" and a crucial step when she finally was able to be in a couple and started imagining the possibility of having a child. It was not something she wanted, as she explains, but what she had to go through. We can also see how the insistence on this personal journey leading to desiring a child becomes independent from chronological and biological age when she says that it "might come back" at 55 and that chronological age only would not be enough from preventing her from attempting to have another child.

By insisting on the life process that everybody goes through, Danièle develops an understanding of age that is very individual and proper to each singular being, allowing her thus to resist the normativity of the life course and life stages. This relativization of what should be done, and when, can be read in the following quotation:

So for me there is no rule. All exceptions exist and this is what makes life so rich. There is an important psychological dimension, motivation, how one feels, how one wants to be, to advance. Physical age is part of life, but for me it is not the most determining. It is not a constraint, up to a certain point, because I think

indeed that having a baby at 65 years old… but I cannot judge the persons who do it, because anyway when one is in such a process, one does not FEEL one is 65 (Danièle, 25.06.2012).

Resisting the normativity of chronological age, by insisting on the inner age that one feels inside, or the "ageless self" (Kaufman 1994), helps to legitimize her own trajectory, but what about the biology of reproductive aging? We can read in this excerpt that for Danièle it is not a determining factor. She does not deny that there is a "physical age" but she does not find that it should determine her choice more than chronological age. She goes even further when she develops the idea that as the age norms of the life course are changing, biology will have to follow:

It is right, you have women who still get pregnant between 40 and 45. So maybe age is mutating, the age of the end of fertility is moving too. I am convinced that the body adapts anyway. It has adapted since millions of years, there is no reason why it should stop in 2012. So we will see in 2300 up to what age, but I think that there is an evolution happening at this level. […] I think that life has been well designed so far. We had mortality rates that were much younger of course, but it is going to change, the body will have to modify, at the cellular structural level, at the physical level, at the energy level, if we all start having our first kids at forty (Danièle, 13.02.2012).

The futurist vision of the biology of aging she imagines here is revealing how she transforms the meaning of the biological limits of fertility as determined and fixed, into something much more malleable that will have to adapt to social transformations. Instead of separating the biology of reproductive aging as fixed, from society as mutable and changing, in her account, society determines biology, and the latter, in a kind of evolutionary perspective, has to adapt to the first one. It is not just that the biology of reproductive aging is one factor among others not determining her becoming a mother, but still fixed, as in Valérie's account. Here the biology of the end of fertility itself is seen as determined by society, but according to an evolutionary perspective that makes it mutable and always becoming over the long-term.

In spite of this vision of life liberated from the normativity of age, in real life Danièle faces several health problems that might be associated with age, but also might not. For example, she suffered from a beginning of pre-eclampsia, a complication of pregnancy that lead her to undergo a C-section in an emergency and to the premature birth of her child. As there is typically an increased risk of this kind of complication in relation to age, when I saw her after the birth of her child, I asked how she had experienced it, but at no time did she frame what happened in the terms of aging. On the contrary, she recalled that her mother and her sister had the same

problems at a much younger age, and that it ran in the family, rather than being a specifically age-related complication. In the same way, back pains and the risk of diabetes are more related to her overweight, than to her age, in her narrative. While the resistance to read the events of her life in age terms can be understood as a way of legitimizing herself, it produces also an original understanding of the naturescultures of age, where the nature of age is less determining and more open to technological intervention and biological evolution or transformation.

8.3.2. IN ORDER TO HAVE NO REGRETS

Danièle presents her turn to egg donation as an obvious decision that did not require much reflection. This is made possible by a specific vision of life whose motto is "in order to have no regrets". She says:

> *In any case, it is important to have tried. I don't want to find myself in five years and think "Shit, we should have tried to do this, maybe we should….". I know I find it very hard living with "if", with regrets. So we proceeded step by step, in a process, from one staircase to the other. When it did not work [with my oocytes], we went into egg donation […] Maybe it will be hard. But I think our relationship is strong enough to go through this. And at least we will live without regret, without thinking that we should have tried. If I want to do something, I do it. And if it does not work, it doesn't, but at least I tried (Danièle, 13.02.2012).*

We can read in this quotation how she insists on the importance of "having tried" in order to live with no regrets. She says that she does not want to persist desperately in doing something, but that it is crucial for her that she does not remain with the doubt of an unaccomplished potentiality. She uses also the metaphor of "the door" to describe her way of seeing the ART's trajectory. For her if there is a door, she needs to see what is behind and will try to open it, but if it stays closed, she will not persist. For example she needed to try IVF with her own oocytes in order not to regret and stay with the doubt that it might have worked, but when the doctor said that her ovarian response was not sufficient, she accepted it and decided to move on to the next step, which was egg donation. While this applies to ART's, she also illustrates her philosophy of life by several professional examples. Being a person of faith, she thinks that if there is a possibility, you have to try, then if it works, it is that God wants you to go in this direction, and if it does not, it means that it is not your path, as one can read in the following quotation:

> *No, this, it is not a question of chance. I think that we are guided on a path on which we have to go. And in fact we have to listen to this path. […] If the door closes, well it closes. For me it is clear, I am*

not the kind to persist desperately during ten years, because if it has to happen, it happens. Full stop! (Danièle, 25.06.2012).

For her philosophy to work in the context of age-related infertility, there must be a possibility or a potential to do something about, or in her words "a door" that may be opened. She stresses this point when she says that she would have accepted the refusal of access if there was no means, but the knowledge of some existing technological possibilities made this initial refusal, and more generally the prohibition of egg donation in Switzerland, very hard to accept. She says:

Nowadays, we have the means to do it. We live in a time where one can, why forbid it? For example, fifty years ago, it was another time, people suffered, suffered, we did not have [the medicine and drugs we have today]… It is something I cannot stand! We have to fight, to alleviate people's sufferings, we know the molecules, we have everything at our disposal. Use it! At the medical level, we have and we don't use, it bothers me (Danièle, 25.06.2012).

Drawing on a parallel with painkillers and the sufferings of people, she defends the idea that once a biotechnological and medical possibility exists, there is no reason why not to use it. This can be described as a "tyranny of potential" (Kaufman 2013) entailing that if there is a chance of extending life or fighting death, an associated moral obligation to do so appears. However, in her case, this process is seen more positively, less a tyranny than an open-ended progress, without the burden of personal responsibility, because a superior entity decides for her what is best.

The way she speaks about her pregnancy as "happiness only" or a "dream" confirms *a posteriori* that she was right to try. Moreover, when she has her child, it confirms this even more, but also that she had to try, because the precious life of her child cannot be thought of as an undone potential. There is no way back or as put simply by Danièle: "If I had not tried, there would be no child" (Danièle, 28.03.2013), which is impossible to imagine once the child is born. These elements come to the fore when she thinks about what she should do with the four remaining embryos. During her pregnancy, she says:

My goal in all this is to have no regrets. We will have done all that was in our power. Then now, do we want a second child at any price? No, there is a second one, because there are embryos and we want to try our luck. If it must happen, it will, that's it (Danièle, 25.06.2012).

As the first pregnancy ended up abruptly putting her health and the health of her child at risk, her relatives, and especially her mother, really feared that they would lose her. In addition,

practitioners are not very encouraging regarding the prospect of a second pregnancy to say the least. However, the last time I saw her, with her child, the frozen embryos which were initially a vague potential for life that could be donated or destroyed, had a change of status. Once her child was born, the embryos became potential brothers and sisters, and their "right to live" started to prevail on the risks she might take, and on the age limits she could be confronted with, medically or socially.

8.3.3. NORMALISING THE MEDICALLY ASSISTED EXTENSION OF FERTILITY

In contrast to Valérie who naturalises the medically assisted extension of fertility by keeping secret her turn to egg donation, Danièle opts for another normalisation strategy. She does not keep the procedure secret, on the contrary, her family, friends, and even her colleagues at work are aware of her trajectory. For her it is a "wonderful gift" and there is no reason to hide it in some way. The broad disclosure strategy she opts for is based on her dislike of secrets, but can also be read as a normalizing strategy. In her view, secrets are associated with shame, pain, and fear, while disclosure is a way of showing that there is nothing shameful or to be afraid of in her decision to turn to egg donation. On the contrary, by speaking openly about it, she aims at showing that even though it is a different way of having a child, it does not make her or her child "abnormal" people.

Even more, she thinks that she might have a public role to play in the acceptance of egg donation in Switzerland, when she says that she has "the feeling [she] has something to do in the transmission of this experience". She fully supports Jessica, presented in the introduction, who at this time has become involved in the politicization of the authorization of egg donation. She also agreed to give a testimony of her experience in a regional newspaper, accompanied by a picture of her with her baby in her arms. Her goal is to show other people the positive side of this possibility. Instead of the moral disapproval that can be read in the newspapers regarding postmenopausal pregnancy cases, she stresses the normality of her desire for a child and a family, that does not distinguish her from the majority of people. She also writes personally to some women struggling with infertility issues on the online forum though which I met her.

Her goal is to share her experience in order to give these other women hope and showing that it is possible. Again, by disclosing her choice to turn to egg donation she aims at making it more normal and at minimizing its importance. Considering herself like a lucky "miracle mom" (Friese, Becker and Nachtigall 2006), she wants to show that there is nothing odd about it. Making her

story and choice public can thus be read as a resistance strategy to the stigma surrounding older mothers turning to egg donation which is especially strong in Switzerland. Paradoxically she transforms the normativity of the life course, by having a child later than the average, but by insisting on the normality of her situation and choice. Through this public disclosure, she tries to normalize her uncommon experience and to legitimize it, in a way that both highlights the singularity of her case and reinscribes it in the normality of desire for a child and for a family.

Intermediary remarks

Following Valérie's and Danièle's trajectories, as they oscillate between having or not having a child and turning or not turning to egg donation, reveals the complexity and ambivalence of their reproductive choices. It especially highlights how active elements, usually associated with culture, and passive elements, usually associated with nature, are distributed and circulated in their narratives. Neither the victims of a society that would push them to have a child later in life, nor of a biology that would prevent them from becoming a mother, they negotiate the medically assisted extension of fertility in a way that complicates both social and biological dimensions of age. Neither choosing freely egg donation like consumers in a "reproductive market" (Spar 2007), nor following passively a prescribed medical path, their stories reveal how on the one hand egg donation does not work as an easy *a priori* technological fix, but also how knowing that there is a biotechnical possibility of "doing something about it" transforms the way they think about the biology of the end of fertility. In this sense the potential of egg donation to extend fertility and to decouple biological and chronological age has powerful effects in the present, not directly as an additional reproductive option, pushing childless women to have a child at any cost in an endless quest, but as making the biology of reproductive aging as only one element, among others, but not mattering more than others, in the choreography of making older mothers.

The fact that they both got pregnant rather easily confirmed to them *a posteriori* that they were right to decide what they did, the child materializing the bright proof of the rightness of their choices, that cannot be unmade, once the child is born. However, paying attention to their careful negotiations during their trajectory highlights the uncertainties in which their choices are made and how they develop strategies to deal with them: the apparent rationality of a statistically-driven decision in Valérie's case and a philosophy of life that entails that one has to try in order to have no regrets in Danièle's case. It enables us also to seize their naturalisation and normalisation strategies. Both stress the importance of "feeling ready" and of an "inner" or "mental age" that is independent to some extent from chronological and biological age, but

Danièle goes even further, positioning herself at the avant-garde of future biological transformations and by imagining a future where biology itself would adjust to society's transformations. The prospect of ageless fertility in the future is used to legitimize and normalize her situation in the present, but also shows how the potential of egg donation to extend fertility has an impact on the understanding of the nature of age limits, for these women in their forties.

The second part of the dissertation has explored the ways in which age is experienced in the reproductive medicine practices and women's experiences and trajectories. While the two previous chapters have shown how the age-related fertility decline materializes, this chapter has focused on the anti-aging dimension of ART and has shown how it is at work in women's narratives and experiences. We can ask how two versions of reproductive aging, as an obstacle to the success of IVF, as shown in the two previous chapters, and as something that can be overcome in order to extend fertility, as shown in the present one, may coexist in women's trajectories. Exploring in depth Valérie's and Danièle's cases allows us to see how the first one is a condition of possibility for the other one to work. In other words, the materializations of "old eggs" is a condition of possibility for egg donation to work as anti-aging. While this anti-aging dimension has been explored in the patients' experiences, the next two chapters will turn to the biopolitics of reproductive aging in Switzerland, and especially to the debates that this anti-aging possibility raises. Moving away from patients, it will focus on the way in which practitioners in reproductive medicine negotiate the boundary between pathological and normal, which is another form taken by the nature-culture distinction.

Part III

Age limits

Imagining and regulating the future of reproduction

9. Fertility extension potentialities in a regime of cautiousness

"Fertility potential", "reproductive potential", "potential new problems", "potential risk of epigenetic changes", "implantation potential", "potential medical complications", "potential false hopes": this declension of expressions taken out of a medical and scientific article on egg freezing and age-related infertility (Wunder 2013) illustrates how often the term "potential" is used, and how various are its referents. These referents range from the statistical probability of pregnancy and implantation rates to the possibility that the IVF procedure affects the health of IVF-conceived children when they are adults by modifying the expression of their genes (Scherrer et al. 2012). The terms "possibility", "risk", "promise", and "(false) hopes" are also part of this lexical register where uncertainties about future events are brought into the present under different modalities.

This chapter examines how the idiom of potentiality is used in debates and public discussions among professionals about egg donation and egg freezing, two technologies having the potential of decoupling age and fertility by assisting medically the extension of female fertility. While the three previous chapters have explored the multiple ways in which age materializes in medical practices and in the individual experiences of patients turning to ARTs, this chapter and the following one move to the biopolitical level in order to highlight the politics of the nature of the age-related fertility decline at stake in the possible intervention of ARTs to extend fertility.

9.1. Temporality and potentiality

Nowadays, many biotechnological innovations and developments are increasingly framed, presented, and sold within the "idiom of potential" (Taussig, Hoeyer and Helmreich 2013) and according to their "promissory capital" (Thompson 2005). Responding to this future-oriented dimension, recent scholarship has thematized and problematized notions of potentiality (Taussig, Hoeyer and Helmreich 2013), anticipation (Adams, Murphy and Clarke 2009), and expectations (Brown and Michael 2003). This literature aims at grasping how temporality is at stake in the governance of biotechnologies and biomedicine and the politics of "life" itself (Rose 2007), but also how economic value is increasingly granted to future potentialities (Thompson 2005). As the future, or the yet-to-be, remains by definition unknown, and is "available to us only through abstraction and the imagination" (Brown 2005: 351), specific attention has been brought to the techniques and devices that allow it to work back into the present, such as risk technology,

"operating by converting the future into calculated, known risks" (Samimian-Darash 2013: 2). The "ways in which imagination become materially or corporeally embedded in bodies, structure, routines, systems, matters, and so forth, such that they assume a future reality status in the present, though often not" (Brown 2005: 353) has also been increasingly investigated.

In this chapter, I am interested in examining how temporality and potentiality are at work in the discussions questioning the future of medically assisted reproduction in Switzerland. The Reproductive Medicine Act (RMA 1998) is currently under revision[95], creating a specific context characterized by the awareness that things could be other than they are. The discussions that I had with medical professionals and the debates on reproductive medicine were characterized by a very specific temporality where the moral horizon of the discussions lies ahead in the future, creating a temporal tension between what is and what might, should, or could be. Even though egg donation has been a standard procedure for many years in other countries, its possible authorization focused discussions on whether the procedure would be authorized one day in Switzerland, whether it was desirable or not, under which conditions, and what it would change. In addition, the recent possibility of freezing one's own oocytes for future use was also very much discussed as possibly changing the landscape of reproduction in Switzerland. This created a very specific space where uncertainties, fears, hopes, and ambivalence, got the upper hand.

The future of medically assisted reproduction is therefore discussed by experts in several sites such as professional meetings and conferences – for example the one organized by the "Kompetenzzentrum Medizin – Ethik – Recht Helvetiae" (Competence Center for Medicine, Ethics and Law) on the Future of Reproductive Medicine[96] – recommendations such as those issued by the Swiss National Advisory Commission on Biomedical Ethics (NEK/CNE 2013), articles (e.g. Bleichenbacher et al. 2010; Wunder 2013), or reports on behalf of the Federal Office for Public Health[97]. In these sites, several "sociotechnical imaginaries" (Jasanoff and Kim 2009) relating to the possibility of fertility extension are framed, and age-related infertility emerges as a matter of governance where the relationship between nature, society, and technologies is negotiated. I argue that the analysis of this specific moment where potentiality, as indexing "the gap between what is and what might, could, or even should be" (Taussig, Hoeyer and Helmreich 2013: S5), predominates, is especially useful if we want to understand the utopian and dystopian imaginary futures related to the extension of female fertility and motherhood in Switzerland. It is

[95] At the time of writing (2014-2015).
[96] "Zur Zukunft der Fortpflanzungsmedizin". The conference took place at Zurich on November 21, 2014.
[97] See the website of the Federal Office of Public Health (FOPH) where the expert reports can be found: http://www.bag.admin.ch/themen/medizin/03878/03882/index.html?lang=en - accessed on December 20, 2015.

also especially relevant in order to grasp the political dimension of the "nature" of the age-related fertility decline, as the regulation of ARTs works towards "realizing particular human futures, while foreclosing others" (Taussig, Hoeyer and Helmreich 2013: S4) by mobilizing this very nature.

I highlighted in Chapter 4 the importance of the promissory work performed by scientists working on the biology of reproductive aging in the controversy about the postnatal renewal of oocytes. Here in contrast, I additionally want to focus on the promissory work performed by experts in the field of reproductive medicine in Switzerland. While the former work is clearly future-oriented and uses the past as an ally in order to strengthen the actuality of the future of reproduction it promises, the latter holds a much more ambivalent position towards the reproductive potentialities opened up by ARTs (see for example de Jong 2015). I will focus on two sites where these ambivalences are very present: the revision of the law regarding the lifting of the ban on egg donation and the possibility of integrating egg freezing in clinical practices. The analysis draws on textual documents related to these two technologies in connection with the regulation of ARTs in Switzerland, such as text position statements or opinions authored by medical experts in the field, but also legal documents, newspapers articles published in the French-speaking part of Switzerland, interviews with various experts, and professional conferences and meetings that I attended.

By focusing especially on the temporality of potentiality, I aim to highlight the centrality of ambivalence in the hopes, imaginaries, and uncertainties at stake in discussions about the future of reproduction. Indeed, in contrast with the terms of risk, promise, or expectation, potentiality "retain[s] a larger degree of ambiguity" (Taussig, Hoeyer and Helmreich 2013: S10) as opening up a space full of uncertainty and unknown that can be imagined either positively or negatively. My question in this chapter is how potentiality and temporality are at work in the discussions and debates surrounding the possible transformations of reproductive medicine. What kind of visions of the future are produced? How is the future active in the present? Under which modalities? But is the past active in the present as well? I will show how, in the Swiss context, the possibility of medically extending fertility is inseparable from ambivalent imaginary futures where social transformations of kinship and gender relations are at stake, but also from the past story of the rather restrictive legal regulation of ARTs in Switzerland. I will also try to characterize the regime of cautiousness underlying the possible transformations of the regulation towards egg donation and egg freezing.

9.2. Demanding the authorization of egg donation

Egg donation is not a new technology and there is no hype (Brown 2003) surrounding it. The first attempts successfully described in the medical literature took place in the early 1980s in Australia (Lutjen et al. 1984; Trounson et al. 1983) and since then, the procedure has spread in many parts of the world, gaining progressively in popularity and legitimacy (Sauer and Kavic 2006). Nowadays in many countries it is considered a standard procedure, in the same way as IVF. It can therefore even be considered as an old technology, as the core technology itself is IVF, that is, the fertilization of egg and sperm outside of the body. This "old" dimension of egg donation appeared, for example, during a presentation on ARTs by a clinician who presented IVF as the core technology and egg donation as just a variation of it that did not need any specific detailed explanation (20.06.2013[98]). Furthermore, as new biotechnologies such as ICSI, IMSI, stem cells and cloning techniques, such as the one enabling the so-called "three-persons babies"[99] (Gallagher 2015), are constantly developed, the older ones such as egg donation become increasingly normalized and standardized (see also Bühler and König 2015; Campbell 2011; Franklin 2013a; Thompson 2005).

However in Switzerland, since the procedure is still banned, the prospect of its authorization creates a novelty, not only at a legal, but also at a clinical and social level. During my fieldwork (2011-2013), the Reproductive Medicine Act (RMA 1998) was under revision in order to authorize Preimplantation Genetic Diagnosis (PGD)[100], which was also prohibited. Taking advantage of the ongoing revision and in response to the submission of a motion asking for the authorization of egg donation (Neyrinck 2012) in February 2014 the Parliament agreed to discuss the procedure and elaborate a draft law regulating it[101]. While a change in the regulation may take a long time before being accepted, it creates a space favourable to the creation of new imaginaries about ARTs and their possible uses.

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[98] "Infertilité et don de gamètes: regards croisés d'une gynécologue, d'une conseillère en santé sexuelle, et d'une anthropologue". The workshop took place in Lausanne and was organized by Nolwenn Bühler.

[99] Three-person IVF' may be performed in the case of severe mitochondrial diseases of the future mother. Her egg's healthy spindle is injected into a previously enucleated egg of a donor which contains healthy mitochondria (Maternal Spindle Transfer (MST)) and then fertilized with the future father's sperm. Alternatively, a similar procedure can be performed on fertilized eggs which are still in the status of a single cell (Pronuclear Transfer (PNT). In both cases, the child that results from this fertilization technique is genetically related to three 'parents' and both procedures constitute irreversible modifications of the germline. See: http://www.geneticsandsociety.org/article.php?id=6527 - accessed on December 30, 2015.

[100] The revision of the law was accepted by popular vote in June 2015 (Chuard 2015). See Appendix 2 for more information on the regulation of ARTs in Switzerland.

[101] The content and the progress of the parliamentary process is published on the following webpage: http://www.parlament.ch/f/suche/Pages/geschaefte.aspx?gesch_id=20120487 - accessed on December 20, 2015.

In order to understand the novelty that the authorization of egg donation might represent, it must be noted that Switzerland has one of the most restrictive regulations, along with Austria and Germany in comparison with other European countries. Centred on the well-being of the child[102], it prohibits not only egg donation, but also surrogacy and the freezing of embryo, and restricts the number of embryos that can be developed outside of the human body to the number that can be implanted freshly (no more than 3, in practice only 1 or 2), as well as the time of their development outside of the human body (no more than 3 days), that is the so-called "rule of three". In addition, access is restricted to heterosexual couples – married in the case of sperm donation – and to medically diagnosed infertility cases. IVF is a very costly procedure (about 6000 to 10'000 CHF for an IVF (ICSI) cycle) and is not reimbursed by health insurance, which also affects those who can finally access these technologies.

9.2.1. IN THE NAME OF A MORE ETHICAL FUTURE?

Who wants the regulation to change and ova donation to be authorized? In the name of what? One could imagine that the couples benefitting from ARTs could organize and fight for a broader access, reimbursement, or the lifting of the existing ban on this procedure. At least two patient associations – Kinderwunsch and Azote Liquide – were formed in the 1990s during the elaboration process of the regulation that entered into force in 2001 (Engeli 2010). But when I started my fieldwork, these associations were not really active any more and most patients whom I met in the French-speaking part of Switzerland had never heard of them. They expressed much dissatisfaction with the current regulation, especially regarding reimbursement, but did not make from this dissatisfaction a matter of sufficient importance to bring them together in an organization or to act at a political level. On the line of discussion dedicated to ARTs of the Internet forum on motherhood and family issues which I followed on an almost daily basis during my fieldwork, I saw at least two attempts to gather people together in order to get signatures or to write a letter to the Parliament in order to support regulatory change, but I did not see these timely efforts succeeding[103].

One could also imagine that LGBTQ[104] people who are excluded from access to ARTs restricted to heterosexual couples would fight for it, or more generally that those "excluded" from ARTs would organize cross-border reproductive care networks and bring their claims into the public arena, as is the case in France (Engeli 2009; Rochebrochard and Rozée 2010). But in Switzerland

[102] A report on this controversial notion has been published by the Federal Office for Public Health (FOPH), see Simoni 2012.
[103] In Switzerland, the absence of patients' political mobilization seems to be a specificity of reproductive medicine, whose causes and reasons remain to be explored further.
[104] Lesbian, Gay, Bisexual, Transexual, Queer.

they do not directly fight for access to ARTs, even less for egg donation or egg freezing, but more generally for their right to marry, which would consequently include the right of access to ARTs (Nay 2013). Single women, who are also excluded from access to ARTs, are even less visible than politically active LGBTQ people, and are not involved in changing the regulation either.

The only group of people working actively to change the regulation and the main actor advocating for the authorization of ova donation is comprised of the clinicians working in the field of reproductive medicine and members of the Swiss Society for Reproductive Medicine (Bühler 2014b). Considered as the "main losers" of the regulation process (Engeli 2010), by seeing the scope of their professional practices restricted and submitted to strict surveillance, they initiated the revision process of the RMA soon after it had come into force by asking for the authorization of PGD in 2000 (Polla 2000). However they remained publicly discreet on the question of egg donation. Yet in 2011, the president of the Swiss Society for Reproductive Medicine (SSRM) and the president of the National Registry FIVNAT-CH wrote an open letter to the Parliament in the name of the SSRM (de Candolle and De Geyter 2011). But even though expressing the official position of the SSRM regarding the revision of the regulation, no publicity was made for this letter which was published in the journal of the Swiss Federation of Physicians (FMH[105]), the *Bulletin des Médecins Suisses* and therefore restricted to an informed and specialist audience.

The letter describes what is presented as a problematic situation of ARTs in Switzerland and explains why changes are asked for. Several aspects of the current situation are considered problematic. First mentioned are elements leading to the high rate of multiple pregnancies, such as the fact that IVF is not reimbursed, that the freezing of embryos is prohibited[106] and that only three embryos can be developed *in vitro* thus limiting the possibility of selecting the best one in order to improve success rates with a single embryo transfer. The article relates also the increasing use of ARTs with the demographic trend to have children later in life, which increases the possibility of infertility problems.

The authors justify the demand for the authorization of egg donation in these terms:

[105] Fédération des médecins suisses http://www.fmh.ch/fr/de_la_fmh.html - accessed on August 20, 2015.
[106] The RMA prohibits the freezing of embryos. Only zygotes that is fertilized oocyte before the fusion of the nucleus can officially be cryopreserved.

> *Finally, while sperm donation is authorized, its female counterpart is prohibited. Many young women, suffering from cancer are currently undergoing anti-cancer treatment (chemotherapy and radiotherapy) at the expense of their fertility. After their recovery, these women can only be pregnant with the help of oocyte donation. Other women, too old to produce their own viable oocytes, go abroad to be treated, as suggested by statistics. The number of women giving birth after 45 has been multiplied by four since 2001. The Court of Justice of the European Union has decided recently that legal restrictions in force in Austria and similar to ours were discriminatory and that oocyte donation should be authorized by analogy with sperm donation*[107]*. In order to avoid uncontrolled medical tourism, a legal adaptation is necessary (de Candolle and De Geyter 2011: 739)*[108]*.*

As one can observe, the present situation is characterized as unsatisfying for both patients and clinicians. Two ethical problems in particular are mentioned: the increasing number of reproductively older women turning to cross-border reproductive care and the inequality between men and women regarding reproductive options that violates non-discrimination rights, as illustrated by the Austrian case. It is thus in the name of ethics that another future for reproduction is asked for, as the authorization of egg donation is seen as having the potential to reestablish an ethically problematic situation.

At the end of the letter, the authors make clear that the procedure should be regulated similarly to sperm donation and within the strict framework of medical indications, as one can read in the following excerpt:

> *We ask for a revision of the current restrictions. The following minimal modifications are demanded: […] 3. To authorize egg donation according to the rules similar to those which govern sperm donation in the limits of medical indications, such the premature loss of ovarian failure due to a disease, to an anticancer treatment, or to prevent the transmissions of serious genetic disease*[109] *(de Candolle and De Geyter 2011: 740).*

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[107] See Bühler 2014b for more information on this case.

[108] "Enfin, alors que le don de sperme est admis, son pendant féminin, le don d'ovocytes est interdit. Nombre de jeunes femmes, affectées par un cancer sont actuellement efficacement soignées par des traitements anti- cancéreux (chimiothérapie et radiothérapie) au dépens de leur fertilité. Après leur guérison, ces femmes ne peuvent devenir enceintes qu'à l'aide d'un don d'ovocyte. D'autres femmes, trop âgées pour produire leurs propres ovocytes viables, se font traiter à l'étranger, comme le suggèrent les statistiques. Le nombre de femme accouchant après 45 ans a été multiplié par 4 depuis 2001. La Cour Européenne de Justice a décidé récemment que les restrictions légales en vigueur en Autriche, similaires aux nôtres, étaient discriminatoires et que le don d'ovocytes devait être autorisé par analogie au don de sperme. Dans le but d'éviter un tourisme médical incontrôlé, une adaptation légale est nécessaire" (de Candolle and De Geyter 2011: 739). Translated by the author.

[109] "Nous demandons une révision des restrictions en cours actuellement. Les modification minimales suivantes sont demandées: […] 3. Permettre le don d'ovocytes en suivant des règles semblables à celles qui régissent le don de sperme dans les limites d'indications médicales, comme la perte prématurée de la fonction ovarienne due à une maladie, à un traitement anticancéreux ou

One can see how ambivalence is at work regarding the question of reproductive aging, as a more ethical future in the sense of a more equal future is demanded for young women, while older women are excluded from the potential uses of oocyte donation. Indeed, while the women aged over 45 are used to defend the lifting of the ban on oocyte donation in the name of a reduction of undesirable reproductive tourism, they are not mentioned in the potential group of beneficiaries from the procedure, which would be restricted to strictly medical conditions. This restriction thus excludes implicitly those women whose ovarian function loss, associated with aging, is not considered pathological or medical in some way.

In this sense the authorization of egg donation is asked for in the name of a more ethical future, but the medically assisted extension of fertility time is rather seen as ethically undesirable and to be prevented for reasons that are not made explicit in the letter. Therefore, one of the consequences of the ban which is presented as problematic, "reproductive tourism", and which concerns older women, would in fact remain unchanged, as they would still be excluded from legitimate access to egg donation. In order to understand the exclusion of older women it is necessary to have a look at the few highly publicized cases of postmenopausal pregnancies, where clinicians working in reproductive medicine are invited, as experts, to express their opinion, as they show in an exemplary way how ethically problematic these situations are considered to be.

The comments on the case of a 64 year-old mother illustrate the ethical concerns expressed by medical experts. For example, a doctor says:

> *When I saw the picture of this baby, I found it very pretty, but I couldn't help feel sorry for her. How will this 64 years old woman handle the fact that she has to wake up in the night at two in the morning to change diapers? Giving birth beyond 50 pertains to a kind of selfishness in my opinion. The life expectancy of these women is also at stake, as well as the fact that it is difficult psychologically to raise a child when there is more that one generation difference with him. […] Sometimes 55 years old women tell me that they feel finally ready to become mother! This unconsciousness always surprises me. I call a provocateur the doctor who would accept to implant an oocyte in this 72 years old Romanian mother. It is unworthy of our profession to put the mother and the child at such risk* [110] *(Bauman 2010b: 22).*

encore pour prévenir la transmission de maladies génétiques graves" (de Candolle and De Geyter 2011: 740). Translated by the author.

110 Original quotation is: "En voyant la photo de ce bébé, je l'ai trouvé très beau, mais je n'ai pas pu m'empêcher de le plaindre. Comment cette femme de 64 ans va-t-elle gérer le fait de se lever la nuit à 2 heures du matin pour changer des couches ? Enfanter au-delà de 50 ans relève à mon sens d'une forme d'égoïsme. L'espérance de vie de ces femmes est bien sûr en cause, mais aussi le fait qu'il est difficile psychologiquement d'élever un enfant quand il y a plus d'une génération de différence avec lui. […] Parfois, des femmes de 55 ans me dissent qu'elles se sent enfin prêtes pour être mère! Cette inconscience m'étonne toujours. J'appelle

Considering that the process is 'unnatural', a clinician interviewed by the popular daily newspaper *Le Matin* says:

> *Enough with the theatre! To love babies at this age, it is ok, but in a grandmother's role. […] The mother will be in a retirement home when her daughter will be 20. What is her future as a teenager, as a student?*[111] *(Donzé 2010).*

Another expert, in the same article adds:

> *Even if egg donation was authorized, I would not do it. In my opinion, the well-being of the child must be the primary criterion*[112] *(Donzé 2010).*

Echoing this concern for the child, another clinician had recalled some years before that according to the RMA (1998), the use of ARTs must prioritize the wellbeing of the child and that parents must be able to raise the child until its majority:

> *Most of the time, it is to repair a narcissistic wound – the woman was not able to accomplish herself through motherhood and the couple could not age with a child – which is not healed. To transfer to the child a problem that is not solved for the adults, is not ethical. It is totally mad, inacceptable. To place a burden upon the child who never asked for anything and that is against nature, we are not entitled to do this*[113] *(Cajeux 2008).*

More recently a 66 year-old mother of twins broke the record (Pillard 2012). When asked about his opinion, a religious representative explains that what is problematic for him is not only that this woman turned to ARTs to create a family, but that her children are born when she is of the age to be a grandmother, thus disturbing the 'divine order of creation' (*Schöpfungsordnung*) which implies that women's fertility is biologically limited in a way that male fertility is not (Von Gut and Reichmuth 2012). Mobilizing the idiom of nature, instead of religion, another doctor answers the journalist's question about the desirability of becoming a mother at the age of being grandmother in regard to the same case by saying:

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provocateur le médecin qui accepterait d'implanter un ovocyte à cette mère roumaine de 72 ans. C'est indigne de notre métier de faire courir un tel risqué à la mère et à l'enfant" (Baumann 2010: 22). Translated by the author.

111 "Arrêtons ce cinéma ! Aimer les bébés à cet âge, d'accord, mais dans un rôle de grand-mère. […] La maman sera en maison de retraite quand sa fille aura 20 ans. Quel sera son avenir d'adolescente et d'étudiante?" (Donzé 2010). Translated by the author.

112 "Même si le don d'ovocytes était autorisé, je ne le pratiquerais pas. A mon avis, le bien de l'enfant doit être le premier critère" (Donzé 2010). Translated by the author.

113 "La plupart du temps, c'est pour guérir une blessure narcissique – la femme n'a pas pu se réaliser à travers une maternité ou le couple n'a pas pu vieillir avec un enfant – qui n'est pas cicatrisée. Transférer sur l'enfant un problème non résolu d'adultes, ce n'est pas éthique. C'est totalement délirant, inacceptable. Mettre sur les épaules d'un enfant un poids qu'il n'a jamais demandé et qui est contre nature, on n'a pas le droit de faire ça" (Cajeux 2008). Translated by the author.

> *No. We have to accept some natural limits and keep our common sense in mind. […] These techniques are above all useful for younger women who suffer from infertility or premature menopause*[114] *(Pillard 2012).*

According to the opinions expressed by the experts in these media comments, women turning to egg donation beyond the menopause would disturb a natural intergenerational and gendered order by exposing themselves and their children to many health risks, as well as to the risk of being orphaned too soon in life or of having to take care of elderly parents rather than studying and being taken care of themselves. The physicians making this kind of pregnancy possible are also pointed at as being guilty of stepping outside of the ethics of the profession and of going too far. Reuniting all the negative characteristics of an unwanted future of motherhood, there emerges a figure that I call the "grandmother mother" to point to the centrality of the intergenerational order that is thought of as pertaining to a natural order of life and is very obvious in the Swiss debates (Bühler 2015), as can be read in the quotations above. Disturbing this natural intergenerational order, this figure works as an ethical foil, enabling all the morally problematic consequences of the medically assisted extension of fertility to be united, and the use of egg donation in younger women to be normalized.

Therefore the apparent contradiction identified in the letter of the SSMR asking for the authorization of egg donation can be read in the light of these ethical concerns as revealing how two imaginary futures are in conflict. On the one hand, reproductive tourism is considered as a unsatisfactory solution, or an ethically problematic situation, to which the authorization of oocyte donation would bring an answer. But on the other, the authorization of egg donation not focused on medical cases, that is to say that would include age-related infertility, stirs up the fear about a spread in postmenopausal pregnancy cases, which in themselves are seen as highly problematic ethically. The authorization of egg donation is thus tainted with ambivalence. On the one hand, it works as a "hope technology" (Franklin 1997; Mulkay 1993) that might enable young women suffering from a medical condition to have a child, while on the other it works as a "fear technology" (Mulkay 1993) where the figure of the "grandmother mother" is used as a foil and embodies all the problems, especially at an intergenerational level, that might develop if egg donation is used to uncouple age and fertility. The way the demand for the authorization of egg donation is framed, and the careful boundary that is drawn between legitimate and illegitimate

[114] "Non. Il faut accepter certaines limites de la nature et garder le bon sens à l'esprit. […] Ces techniques sont surtout utiles pour des femmes plus jeunes qui souffrent d'infertilité ou de ménopause précoce" (Pillard 2012). Translated by the author.

potential users, is a key aspect of what I call the "regime of cautiousness" characterizing Switzerland's approach to the question of ARTs.

Martin, Brown and Turner (2008) themselves drawing on Moreira and Palladino (2005), highlight a shift from a regime of truth to a regime of hope, that is to say "from a rationalistic authority embedded in the past and present towards the speculatively possible in the future" (Martin, Brown and Turner 2008: 128). The demand for the authorization of egg donation is thus not inscribed in a regime of hope, as the promise to alleviate sufferings and providing a better life is not its prevailing narrative. It is not inscribed either in a regime of truth, because the rhetoric used is not based on actual facts and the imaginary and future-oriented dimensions are very much represented. Therefore I argue that what characterizes the positioning of reproductive medicine specialists advocating for the authorization of egg donation is a regime of cautiousness. It distinguishes itself by the importance of an ethical-boundary work (Ehrich et al. 2006; Wainwright et al. 2006) where changes are demanded in the name of a more ethical future and in the name of an unethical present – inequality between men and women, and reproductive tourism. What characterizes it also is the ambivalence at work in the sense that at the same time as a more ethical future is mobilized to legitimate the authorization of egg donation, an unethical future is envisioned justifying the need for caution. The figure of the "grandmother mother" embodies this unethical future, where the use of donated eggs in IVF would be used to bring about pregnancy in postmenopausal women, raising all sorts of moral troubles especially at the level of intergenerational relationships. This ambivalence is productive as it legitimates the demand for an increased openness of the legal regulation, while staying on the good side of ethics. In order to go further in the characterization of this regime of cautiousness, I would like to focus more in details on the "ethical-boundary work" performed by medical experts.

9.2.2. THE NEED FOR ETHICAL LIMITS

The concept of "ethical boundary work" is inspired by Gieryn (1983) who uses it to describe the work performed by scientists in order to delineate what pertains to science and what does not. Wainwright et al. (2006), as well as Ehrich et al. (2006), use it to draw attention to the practical dimension of ethics in scientific and medical activities, not so much to differentiate science from non-science, but to draw a line of demarcation with "less ethical positions" (Wainwright et al. 2006: 745). The use of ethics to show how unethical the Swiss situation is regarding ARTs and why some things should be changed in favour of a more ethical future, were very obvious in the interviews with experts. The current situation and prohibition of egg donation is considered as

having unethical consequences in the present. Especially the phenomenon of international reproductive tourism[115] is pointed out as the unwanted and most problematic consequence of the prohibition as already identified in the letter (de Candolle and De Geyter 2011) analysed above. Several logics underlie these statements, as one can read in the following excerpt of discussion:

> *It is ridiculous because it is an open secret, because finally everybody does it, so our interest would be in doing it here and in controlling things rather than doing this international tourism. […] So I am in favour of it under strict conditions (Dr. E. 21.12.2011).*

Here, one can observe a logic of transparency in association with the idea that better medical services might be provided if clinicians did not have to hide the fact that women go abroad to access egg donation. The idea of transparency is not separable from a desire to control the situation better. "Control" here can be understood in both senses: that the procedure would be better regulated – medically and legally – if it was done in Switzerland, but also that a whole field of practice escaping the expertise of Swiss practitioners for obscure reasons could be reappropriated. Even if not directly mentioned, it implies also a financial dimension, as it would increase the number of patients turning to Swiss medical services instead of going abroad.

A logic centred on the curing role of reproductive medicine underlies a second excerpt:

> *I think that it should be available in Switzerland. It is good to have some conditions restricting access. I think it is very reasonable. Like sperm donation, it is accessible to married couples. We could do the same with egg donation. But at least… when we have a client who presents a menopause after chemotherapy and who is healthy or who had a malformation and surgery in childhood and who has been sterilized, or others who have unexplained menopause, we have just nothing to offer! We say that they need to go to Spain. I think it is barely tolerable. If only it could at least be accessible for these people, it would already be better than what we have now (Dr. C. 10.01.2012).*

The idea is that as a treatment exists, not being able to use it for those persons suffering from a medical condition, and sending them abroad because of a legal restriction, is not ethical. It is the potential of oocyte donation to treat young infertile women who have no other option that dictates the will to have it authorized. This logic can be read as a "tyranny of potential" (Kaufman 2013) entailing that once a technology exists, there is a moral obligation to provide it to patients,

[115] The term "reproductive tourism" is controversial in the literature on ARTs. The term "tourism" especially criticized as it implies a free choice with the connotation of having fun, while it could be described on the contrary as "reproductive exile" (see Inhorn 2009). The term cross-border reproductive care is currently preferred in order to avoid these connotations (Shenfield 2010). I use "reproductive tourism" as an emic term because it is the one used by people I talked to ("tourisme de la reproduction", "tourisme de la procréation" or simply "tourisme medical" were mainly used).

making it very difficult to deny them access. However, here again, the need for limits and a minimal demand, as only for those clearly medical cases who really have not other option, is formulated.

Another logic can be identified in this last quotation:

> *What is sure is that with egg donation we are currently in a situation similar to the voluntary termination of pregnancy in the sixties. That is to say with an important medical tourism resulting in a broad range of complications, psychological and physical, […] I think that we should rather allow a certain amount of things. One will never authorize everything, personally I don't think we should, and medical tourism will always exist, because procreation touches something so deep in the human being that some people are ready for anything to achieve this. […] So if we can care for these women within a proper system, I think that it finally is an advantage (Dr. B. 25.01.2012).*

The comparison with the history of medical abortion inscribes the access to egg donation in women's fight for their reproductive rights, but also highlights that the prohibition entailing medical tourism has worse consequences in the end than the authorization would have. Underlying the doctor's argument above is a feminist logic centred on the negative consequences of the ban on oocyte donation for women. Rather than avoid the so-called reproductive tourism, what is considered as unethical are its psychological and physiological consequences for women that could be at least partly avoided by the authorization of oocyte donation.

In all three quotations, the authorization of egg donation is associated with more ethical futures, while the need for limits is also reasserted. In Switzerland, the insistence on the need and the importance of setting limits to biomedical possibilities in the discussions with clinicians struck me. I could observe that in the Swiss context, the idea of setting limits becomes equated with the good ethics of medical practices, themselves equating with the fact of acting within the framework of the legal regulation, to the extent that sometimes these terms become interchangeable. A presentation of the Swiss regulation determining medical practices is a usual part of public information sessions on reproductive medicine (Bühler 2014b) and the majority of the clinicians I met insisted on the importance of having limits, a sign of good ethics, as illustrated by the following excerpts of interview:

> *Ethics is not easy. It's probably similar in other professions, but when one practices this profession, one needs to set limits for oneself, limits that I call ethical. It helps a lot to know what one must do and what one must not, which is the practitioner's daily bread (Dr. A. 05.12.2011).*

> *Personally, I don't think that it is desirable to do everything that is done everywhere. Indeed, there are things that are excessive. I think that it is good to have a protective barrier from an ethical point of view (Dr. B. 25.01.2012).*

Here, limits become equated with ethics. To set limits is to be ethical, and to be ethical is to act according to the regulation. The visible concern for ethics displayed by experts in the public debates on post-menopausal pregnancies and in the official position presented in the SSMR open letter are part of a regime of cautiousness where changes in the regulation are possible only by mobilizing a more ethical future and by contrasting it with an unethical one and constantly drawing a line between them. Ethics is the only language which they can use publicly to resist the negative image of "sorcerer apprentices" (Dr. B. 25.01.2012 and Dr. F. 02.05.2012) pushing the limits and going too far which is very clear in public discourse. This cautious attitude and the ethical boundary work (Ehrich et al. 2006; Wainwright et al. 2006) are likely due to the very pragmatic wish to avoid a negative reaction from the public by asking "too much", as expressed by these clinicians:

> *The goal is to demand things that can be accepted by the majority of the society of this country. We will not ask for things that will obviously be rejected, maybe what we demand will already be rejected (Dr. A. 05.12.2011).*

> *We have to deal with an extremely apprehensive population in this area. So we will not shock public opinion. This is why some practitioners are against too much openness to oocyte donation and have made an extremely cautious proposition, limited to problems of strict physio-pathological nature, and not related to age (Dr. B. 25.01.2012).*

These two last quotations show how the past history of the regulation of ARTs in Switzerland is still very much active in the present, in the fear of a negative reaction of the population, and orients the public positioning of reproductive medicine experts on the future of medically assisted reproduction. To understand how the past is active in the present, let us turn briefly to the history of the regulation of ARTs.

9.2.3. When the past is still very much present

The RMA entered into force in 2001 following a long decade of fierce debates on which procedures should be allowed or prohibited and more generally on the role of ARTs in the making of families. A climate of fear and mistrust towards possibilities opened up by new

biotechnologies surrounded the implementation of the regulation (Engeli 2010; Schmid 2009). Twice initiatives were launched. The first one, entitled "Against the abusive use of reproductive technologies and genetic manipulation of the human species"[116] was launched in 1987. In 1992, the second one entitled "For a reproduction respecting human dignity"[117] was launched in reaction to the adoption of the constitutional article (Article 119 on medically assisted procreation and genetic engineering in the human domain[118]) by popular vote authorizing IVF under strict conditions. Launched by conservative and religious parties, these initiatives aimed at prohibiting any extra-corporeal conception in the name of the protection of human dignity, the family and the well-being of the child (Engeli 2010). However, surprising alliances were made, as feminists were against IVF, seeing it as exploitative of women's bodies, which contributed to the emergence of the coalition "against nature" (Engeli 2010).

In 1998, the RMA was adopted by popular vote as a counter-project to the initiative launched in 1992. At once, applying and interpreting the constitutional article asserting that "the human being must be protected against abuses with regard to medically assisted reproduction and genetic engineering"[119] (Article 119.1) and regulating some specific conditions to the practice of ARTs such as the number of embryos that can be developed out of the woman's body and the prohibition of surrogacy and embryo donation (Article 119. 2c and d), the law on ARTs added the dimension of the wellbeing of the potential child, a moral principal that lies at its core (RMA 1998).

The debates surrounding the elaboration of the regulation show how the biotechnologization of reproduction opens up an ambivalent space where rhetorics of hope and fear (Bloomfield and Vurdubakis 1995; de Jong 2015; Mulkay 1993) compete, and where technologies are imbued with the potential to disrupt and disturb fundamental social categories such as motherhood, but also to harm families, human beings, human dignity, and the well-being of the child. While potential is an ambiguous notion which can be either positive or negative (Taussig, Hoeyer and Helmreich 2013), in this first phase of the regulation, is it rather the potential harm done by ARTs, the potential to cause trouble for society, family, and individuals which predominates. Dystopian visions of the future of family, society and IVF-conceived children determine thus the framing of

116 Contre l'application abusive des techniques de reproduction et de manipulation génétique de l'espèce humaine.
117 Pour une reproduction respectant la dignité humaine.
118 Procréation médicalement assistée et génie génétique dans le domaine humain.
119 "L'être humain doit être protégé contre les abus en matière de procréation médicalement assistée et de génie génétique" (Article 119.1.)

the law as a protection against potential abuses and misuses and more generally against IVF's potential for transforming society and especially gender and kinship basic categories.

A decade after the law entered into force, IVF has increasingly become a standard and normal procedure, and the anxieties about the troubling potential of ARTs have not materialised. However, when it comes to egg donation the situation is slightly different. When I started fieldwork, a strong sense of "taboo" and "secrecy" surrounded my discussions with experts about this procedure. As oocyte donation is prohibited, but not directly the provision of information on the procedure, clinicians found themselves caught in a complicated grey zone where they could not perform the procedure themselves, but were not explicitly prohibited from supporting women turning towards oocyte donation in a foreign clinic. The prohibition secreted a sense of something morally wrong that could be seen in the difficulty to speak about the concrete role and contribution of clinicians in the circulation of women and in the vagueness surrounding their actual trajectories, about which little was said.

However I could observe an increasing openness and acceptance of the procedure during my fieldwork, as the subject has become spoken about in public conferences and professional workshops. In addition, the official acceptance by the Parliament to examine its possible authorization, as well as the last recommendations of the Swiss National Advisory Commission on Biomedical Ethics (NEK/CNE 2013), suggesting that egg donation and surrogacy should be authorized, and stressing more the reproductive rights of individuals than the well-being of the child, all constitute signs of a shift from the fear about abuses that characterized the first phase, to the regime of cautiousness characterizing the current moment.

The regulation carries with it all the fears and anxieties about potential abuses of ARTs that constituted the frame of its making. While more generally the situation has changed from the predominance of fearful futures to more ethical futures, these fears are still very active in the present and are at work in the cautiousness underlying the demand of the authorization of ova donation. It can be read in the fear of asking too much as an anticipation of a negative reaction that might lead to a leap backwards, and in the difficulty of speaking openly about the procedure. In addition, cautiousness characterizes also the way of advancing slowly, step by step, as shown by the politically strategic demand for the revision of the law, asking first for the authorization of PGD and then, in a second phase only, for the authorization of egg donation, for fear that their combination would raise too much opposition. Therefore the present regime of cautiousness is not only characterized by an ethical boundary-work leading to asking for changes in the name of

a more ethical future, but is also haunted by the fears of the past that still have an impact in the present.

Interestingly, the uncertainties associated with the future of egg donation in Switzerland differ from the introduction of new technology. What is unknown is how the Swiss people will react to the specific concrete and material conditions associated with the practice of egg donation. But in contrast with a new biotechnology, where all countries face the same kind of uncertainties, with egg donation it is possible to draw on other countries' experience. A good example is the report that I wrote for the Federal Office for Public Health (Bühler 2014a) in order for them to imagine what the future of egg donation in Switzerland might look like and to anticipate what will have to be discussed and taken into account by drawing on "lessons to be learned from other countries". What is to be anticipated are the potential debates and difficulties, but also the zones of agreement, on which people in charge of authorizing the procedure could rely on. This report can also be read as a cautiousness technique consisting of waiting first and seeing what happens in other countries, before implementing the technology. More than relying on the truth of other countries' experiences, what is highlighted are the multiple possibilities, or multiple truths, that might be available in imagining and framing the future of egg donation in Switzerland. The cautious attitude animating the will of this report is at the intersection of the past of other countries experiences, but also oriented towards the future, as what is searched for is a picture of what the regulation of egg donation in Switzerland might look like in some years' time. In order to characterize further how potentiality and temporality are at work in the regime of cautiousness framing the regulation of ARTs, I would like to turn to another technique enabling the extension of fertility medically: vitrification, or egg freezing.

9.3. Integrating "social egg freezing"

Vitrification is one of the last products of a long history where "cold" has been used to preserve and transport cells and tissue in animal breeding and reproductive medicine (Gook and Edgar 2007; Radin 2012). In contrast with human sperm freezing, which has been successfully performed since the 1950s when the first human live births from cryopreserved sperm were reported (Bunge, Keettel and Sherman 1954; Bunge and Sherman 1953), and which has, since then, become a standard procedure in reproductive medicine to the point that sperm banks can even sell and ship male gametes all over the world (Almeling 2007; Kroløkke 2009), it was only in the 2000s that oocyte cryopreservation became increasingly performed and tested. On a technical level, it consists of an ultra rapid cooling process where oocytes are put into extremely low

temperature with products which prevent the formation of ice crystals from the high water content of the oocyte (Cobo et al. 2013). Its goal is to create a state of "suspended animation" (Franklin and Lock 2001) or "latency"(Radin 2013) in cells, tissues, or body samples.

By enabling the preservation of oocytes for later use, vitrification represents a new fertility preservation strategy for women undergoing anticancer treatment (Martin 2010), but also for women anticipating age-related infertility (Cobo et al. 2013), or gamete exhaustion (Stoop et al. 2014). The procedure of egg freezing gained an increased level of recognition and legitimation in 2013, when the main European and American reproductive medicine societies – ESHRE, ASRM and SART – agreed rather cautiously to remove the "experimental label" from the procedure (ASRM and SART Practice Committees 2013; Eshre Task Force on Ethics and Law et al. 2012).

In contrast with egg donation, whose novelty comes from its prohibition and possible authorization, egg freezing is more surrounded by the hype (Brown 2003) of a new biotechnological development. Especially in the US it has invaded the Internet and women's magazine stirring up many discussions and debates, as illustrated by the book written by Sarah Elizabeth Richards (2013), *Motherhood rescheduled: the new frontier of egg freezing and the women who tried it,* and the discussions it raised (e.g. Rosenblum 2014; Urist 2013). The removal of the experimental label was associated with the publication of articles expressing personal opinion on the subject (e.g. Inhorn 2013) and especially with the announcement by big Silicon Valley companies, Yahoo and Facebook, that they proposed to pay for the procedure of egg freezing for their women employees, which caused a big controversy (e.g. Allen 2014; Almeling, Radin and Richardson 2014; Fox 2014; Mahoney Tsigdinos 2014).

In contrast, in Switzerland the technique has been rather more slowly and discretely integrated. A review of the newspapers published in the French-speaking part of Switzerland shows that in a first phase there are some articles which speak about this new biotechnological possibility (e.g. Petit-Pierre 2012; Pomper 2011; Schäfer 2010), and that their number increased in 2013. This increase is due to the removal of the experimental label, making the possibility of its use more likely. In addition, it is due to the Facebook and Apple controversy (e.g. Conti 2013; Danthe 2014; Grau 2013; Herzog 2014; Krafft 2014; Lietti 2014) marking a turn in the public visibility of the procedure. However, during my fieldwork (2011-2013), I did not observe any big public social debate on the question.

Among professionals, the possibility of integrating egg freezing among clinical practices has given rise to discussions about the technicalities of this integration (interview with Dr. H. 20.02.2012) and about the legitimacy or even the legality of proposing this procedure in a country where ARTs are strictly regulated (Bersier 2014). Indeed the possibility of cryopreserving oocytes was not taken into account at the time of drafting the RMA. Therefore it is not explicitly forbidden and thus under Swiss law it is allowed. However, as the regulation restricts access to medical cases of infertility, the use of ARTs in order to preserve oocytes and fertilize them when the woman has decided to, without any medical reasons, is very much discussed. In addition, the RMA restricts to five years the time span of gamete cryopreservation (RMA 1998, art.15.1), which is already considered too short for couples who have to use their embryos during this period of time, and which would be even more problematic when it comes to preserve oocytes for later use in order to circumvent the effects of reproductive aging.

9.3.1. The ambivalent promise of an ageless reproductive future

Egg freezing is a "promise technology". Even though there is a crucial lack of hindsight regarding its working in the future, its promises work in the present as the performing of this promissory future. The procedure is temporally divided into two steps: first the hormonal stimulation, retrieval of the oocytes and their cryopreservation, an operation that can be repeated in order to obtain a sufficient number of oocytes; second, years later, their thawing, fertilization through FIV-ICSI, and implantation in the uterus. Due to this time lag, there is by definition a current lack of hindsight on the second step of the procedure. However, the promise of the second step to be efficient later, works actually in the present in a performative way as if it would happen. I would like to contrast now the ambivalent facets of this promise in Switzerland, firstly by analysing the early positioning of medical experts, and secondly by turning to a clinic's advertisement which proposes it.

In 2010, the self-proclaimed Advisory Group on Assisted Reproductive Therapy, or AGART, gathering representative Swiss experts in reproductive medicine and associated fields – andrology, neonatology, psychosomatic medicine, and genetics – published an article on their vision of the future of medically assisted reproduction in Switzerland and took into account the future possibility of preserving fertility (Bleichenbacher et al. 2010). The article is the account of a meeting where they discussed 21 theses or propositions in relation to the future of reproductive medicine. These theses are ordered under three headings: society changes, new therapeutic options, and health policy, three categories that might impact on the future of reproductive

medicine. Five of these propositions particularly concern age-related infertility and one concerns egg donation. Briefly, relevant social changes taken into consideration are the increase in life expectancy, the desire for a child at an older age, and the possibility of saving gametes to preserve fertility in the future. At stake is a wish to prevent age-related infertility by improving the diffusion of information on the fertility decline, and from age 35, information on the possibility of oocytes cryopreservation. Medical risks associated with older pregnancies and the possibility that it would only be available for women coming from a more privileged social class, justify the suggestion to set 40 years of age as the limit to the use of cryopreserved oocytes. What is interesting is that next to medical risks, the notion of "sociological risks" emerges, referring to the possible impact of ARTs on the behaviour of couples and especially women. This category of "sociological risks" remains vague and is not explicitly defined, but it shows how these medical experts include society, or possible social changes to it, in their reflections about the future of reproductive medicine.

In this article, there are no clearly developed utopian or dystopian visions of the future. Rather, what is put in the foreground is the right to information based on what is already known about the limits of reproductive medicine, and the limits of the biological fertility decline. What is at stake is the elaboration of reproductive medicine's answers to future social, technological and medical changes and development. The importance of a right to information is the sign of a cautious attitude towards uncertainties related to technological development and use. When it concerns information about age-related infertility, it is seen as a defence against the social trend to postpone motherhood and against potential abuses of ARTs – imagined as a generalized use of egg freezing – and thus as a kind of prevention. However, age-related infertility, while considered as a condition in need of prevention, is not defined as a disease, and egg freezing is not seen as a form of preventive technique as is the case in Israel (Shkedi-Rafid and Hashiloni-Dolev 2011). Rather, the contrary: egg freezing when used by older women, and hence the uncoupling of age and fertility, is seen as an undesirable possibility. What is prevented by the provision of more information on the biological limits of fertility is not only a specific form of infertility, namely the kind which is related to age, but the use of ARTs in non-strictly defined medical cases and related medical risks. In establishing the goal of reproductive medicine as a prevention of the medically assisted extension of fertility and thus of "social risks" in the sense of social transformations on the means of making a family, these experts stress the need for social continuity, including continuity in family forms, which is ensured by the restriction of ARTs to medically defined conditions (this point will be explored further in Chapter 10).

Some clinics in Switzerland have since then started to propose egg freezing, without great success so far as I was told personally. Some clinics present it as a medical option among others without much publicity (see for example the website of the private centre CPMA[120]), while others have more of an advertising message. This is interesting as it reveals how the promise that egg freezing will work is framed. As an example, one can have a look at the website of Ovita[121], a reproductive medicine clinic offering oocyte cryopreservation in five European countries, including Switzerland in a rather offensive way (Bersier 2014; Wunder 2013). It describes its activity in these terms: "Ovita stocks the healthy oocytes that were retrieved at a younger age thus helping to stop their natural aging process". Accompanying this description, messages highlighting the potential of egg freezing to "open up new prospects for the personal future" can be read: "Since Einstein and social egg freezing we have learned that time is relative. In many cases, the cryopreservation of eggs constitutes an option for those who want to preserve their fertility" or in even more explicit terms: "The future belongs to social egg freezing".

Answering the usual concerns thought of as prompting women to postpone motherhood – a career and finding the right partner – it also gives an apparently liberating and empowering message with slogan such as "I choose the right moment", "Find Mr. Right", or "You can have both [career and family] with the help of social egg freezing!". Accompanying these slogans, pictures of relatively young, white, pretty and neat women are displayed. Next to them one can also see a clock symbolizing the passing of biological age, and a graph showing the statistical decrease in chances of giving birth with age advancing. Above the statistical curve one can see a minus sign with the percentage of decrease to be read in association with age (-6% at 25, - 14% at 30, - 34% at 35).

Embedded in a neoliberal discourse of choice (see for ex. Kaufman and Fjord 2011; Konrad 2005; Van der Sijpt 2014) and in a romantic view of the couple and the nuclear family (Waldby 2014), these slogans are formulated in a way aimed at stressing the potential of egg freezing to enhance women's reproductive self-determination. Visualized in the clock and the decreasing success rates, the age-related fertility decline is seen as an obstacle to their accomplishment as women wanting to reconcile the demands of their career with their desire to start a family at the right moment and with the right person. The nature of the age-related fertility decline is here presented as an ineluctable process, as irreversible as time passing, and as decreasing as the statistics curve. In this way technology seems to both liberate women from biological constraints

[120] http://www.cpma.ch/fr/treatments/fertility-preservation/index.html - accessed on August 25, 2015.
[121] http://www.ovita.eu/en-us/eizelleneinfrieren.aspx - accessed on August 25, 2015.

by acting on the irreversible process of reproductive aging and to strengthen the norms of the nuclear family and of the making of a child as a natural prolongation of the love of the heterosexual couple. Presented as the most important revolution for women since the contraceptive pill and echoing the feminist slogan, "a child, when I want, if I want" (Zech 2011), egg freezing seems thus to give rise to a utopian future where women would be able to have more control over reproduction, and paradoxically would be in a better situation to accomplish their reproductive wishes[122].

These contrasting examples highlight two facets of the ambivalent promise of egg freezing. On the one hand, its promise to work as an option to anticipate the effects of reproductive aging on fertility is resisted and what shall be prevented is rather its generalized use and the "sociological risks" associated with the decoupling of age and fertility. On the other, its promise to liberate women from the constraints of time and of reproductive aging is used as an advertisement to attract patients. Even before that, oocytes, as reproductive cells, themselves get imbued with biovalue, the promise only that it might liberate women from the "biological clock" is imbued with a "promissory capital" (Thompson 2005) worth financial investment as shown by the clinic's advertisement described. Thus egg vitrification articulates two visions of the future, one, dystopian, where its use must be prevented, in order to avoid social transformations and ethical problems related to older motherhood, and another, utopian, where its use must be encouraged in the name of women's freedom and empowerment, as it promises to liberate them from biological and professional constraints.

9.3.2. LEAVING UNCERTAINTIES FOR THE FUTURE

In 2013, egg freezing for social reasons was still very much discussed in the field. Due to removal of the experimental label, several articles were published on the topic and a professional workshop on "social oocyte vitrification" reuniting experts in the field of reproductive medicine was organized in order to discuss the possibility of integrating the procedure in the range of medical options practised in Switzerland. Firstly, a medical expert published an article on egg freezing in a Swiss medical journal in February 2013. This expert was active in the public debates on ARTs and was very often interviewed in the newspapers. Entitled "Social freezing in Switzerland and worldwide – a blessing for women today", the article starts by denouncing the false promise, made by some centres providing the procedure, that it might help women to

[122] Feminist critique has highlighted how in fact by seeming to liberate women, egg freezing might actually put even more pressure on them and strengthen the norms of the right moment to have a child, as well as the expectations for women to anticipate their reproductive future (Martin 2010).

"harmonise incompatibilities" between career and motherhood (Wunder 2013). The largest part of the article is then dedicated to the various risks that might be associated with the use of egg freezing.

Due to the lack of hindsight on risks association with vitirification, the article draws on actual statistics ranging from neonatal and maternal risks, to risks associated with the procedure of IVF, such as risks of failure and of ovarian hyperstimulation syndrome[123], and transposes them to think about the future of the technique. Neonatal and maternal risks of primiparity at an advanced maternal age (over forty) are detailed. Then the risks and adverse effects of IVF-ICSI are listed. Risks based on actual data and potential risks tend to merge, and uncertainties are pointed out over and over again. For example, well-documented health risks associated with late pregnancies are next to "potential risk of epigenetic changes and imprinting defects after in-vitro cultures". Regarding the possible malformation rate in children conceived after IVF-ICSI, it is recalled that "it is unclear today if IVF patients without infertility would lead to the same elevated malformation rate in children or if it would be different because there is no inherent infertility factor" (Wunder 2013: w13746). One can also read below that:

> *The risks of long term health effects in children conceived after IVF-ICSI cannot be specified yet. Study results have shown an increased cardiovascular and cardio metabolic risk in healthy children after IVF-ICSI. However the clinical impact of these findings and the clinical long term consequences are not yet clear (Wunder 2013: w13746).*

A special heading is dedicated to the "risk of failure (respectively chances of success)", where it is stressed that:

> *There are no concrete data in literature concerning the "baby take home rate" per thawed unfertilized oocytes" and that "the chances of becoming pregnant after preservation of oocytes depend on the one hand, on the number of the cryopreserved oocytes, but on the other hand, on the biological age with its impact on spindle configuration and chromosomal arrangement. Both decrease dramatically with age. Women considering social freezing, are unfortunately very often around 38 years of age, which leads to a very low cost-efficiency (Wunder 2013: w13746).*

[123] The kinds of risks examined in the article are: maternal risks; neonatal risks; perinatal outcome after ART; malformation rate in children conceived after IVF-ICSI; malformation rate in children conceived after freezing-thawing of unfertilized oocytes and consecutive ICSI; long-term health effects in children after IVF-ICSi; risks of failure; risks of ovarian hyperstimulation syndrome; risk of oocyte pick-up. As the vitrification procedure is very recent, only one study on the outcome of children after vitrification.

In this article, a cautious stance towards the "false promise" of egg freezing is put into the foreground. The many uncertainties and medical risks presented, both actual and potential, point to a dangerous future for the women and for the children, if the technology were to be used widely. In the name of a safer future, cautiousness should be applied to the use of egg freezing, and especially its promise to liberate women is pointed out as "false" by the listing of the many risks it might be associated with.

One of the medical experts who organized the workshop on "social oocyte vitrification" mentioned above, took a position publicly on the question. He was interviewed in the women's popular magazine *Femina*, in an article entitled "To freeze one's own oocytes, a debate in gestation"[124] (Grau 2013) two months before the workshop took place. To the question of the journalist asking whether egg freezing might help women to fill the gap between the social trend to have children later in life and the age of menopause, he answers: "It is a topic we have to approach with much cautiousness because it is new and disconcerting"[125]. About the guarantee to have a child with cryopreserved oocytes, he then adds: "One must demystify straightaway: medically assisted reproduction does not work every time"[126] and stresses that there is a lack of hindsight with vitrification. To the journalist asking whether there could be a generalized use of egg freezing, he answers negatively saying that the procedure is very costly (4700 CHF for the retrieval and then between 6000 CHF and 15000 CHF for the thawing and the FIV-ICSI) without any guarantee that a pregnancy will occur. He concludes by stressing the promissory dimension of the procedure by saying: "It is a financial investment, but also intellectual and fantastical"[127].

The impression emerging from the article is that this possibility is not really taken seriously, and especially that it is still full of uncertainties regarding its actual working and the social and ethical questions it may raise and that need to be discussed. The attitude of these two doctors is representative of the regime of cautiousness characterizing the Swiss position of experts on the possibilities opened up by ARTs, where uncertainties are first put into the foreground, resisting the hype associated with new biotechnologies, and encouraging the adoption of a slow progress regarding future possibilities.

An important moment of my fieldwork highlighting how this question was discussed took place in June 2013, at the above-mentioned professional workshop that I attended. It was organized by

[124] "Congeler ses ovules, un débat en gestation".
[125] "Il s'agit d'un sujet sur lequel on avance très prudemment car il est nouveau et déroutant".
[126] "Il faut démystifier d'emblée: la procréation médicalement assistée ne marche pas à tous les coups".
[127] "C'est un investissement financier, mais aussi intellectuel et fantasmatique".

private clinics as a continuing training course on what is called "social oocyte vitrification"[128], also commonly called "social egg freezing". It took place in a very nice hotel on the Leman Lake shore on a sunny summer day. It was funded by the pharmaceutical companies Serono and Merck, as well as by the Fondation Faber, a nonprofit private foundation dedicated to research on ARTs[129]. Two foreign experts – from Spain and UK – with extensive experience with this new technology were invited and several Swiss biologists, clinicians, legal experts, and ethicist, presented papers on the multiple aspects of this new biotechnological possibility.

As the technology is characterized by its novelty and associated lack of hindsight, much of the discussion drew on the idiom of potential. Its potential to secure reproductive futures, as well as its potential for big business, along with its revolutionary potential in respect to the reproduction options available for women in a way similar to the contraceptive pill and the resulting separation of sex and procreation were highlighted and discussed. During this workshop, egg freezing for social reasons, as it was called, was also presented as a potential solution enabling the avoidance of cross-border reproductive travel entailed by the prohibition of ova donation, as well as ethical problems related to the recruitment, treatment and compensation of egg donors. Its role in preventing disruption to the genetic line and the resulting fragmentation of motherhood was especially stressed. In fact, the greatest risk to be anticipated by turning to egg freezing is, as expressed by one of the participants, to stay involuntarily childless, and being forced to turn to egg donation. Egg freezing was thus presented as a potential means of avoiding the use of donated eggs and thus of producing genetic continuity between generations by preserving the genetic line between mother and child (see also Martin 2010; and Waldby 2014).

Several topics stood out from the discussions and are especially relevant in regard to the potentiality of ARTs and the future of reproductive medicine. One of the main topics addressed during this one-day workshop was about the fear that the promise technology that is social egg freezing would generate "false hopes". Many uncertainties are associated with the future of this technology. For example the age at which it would be appropriate to freeze one's own oocytes is not exactly known. The risk is that if women cryopreserve oocytes too early in their life, in their early twenties, they will not use them, said a participant, while if the decision to cryopreserve is taken near to age forty, then the risk is that it will be too late. In fact the paradox is that "too early", the chances that it will work later would be increased because of a better quality, but if it is performed "too late" when it would be most useful, the chances that it will work would be lower

[128] Vitrification des ovocytes à but social.
[129] http://www.fondation-faber.ch/faber_f/pages/la-fondation.php?lang=FR - accessed on August 25, 2015.

because of the reproductive aging process. The number of oocytes that should be retrieved also remains unknown. How many oocytes should be preserved in order to guarantee a minimal rate of success? And what would be a minimal acceptable rate of success? In Switzerland the cryopreservation of gametes is limited to 5 years, and that would therefore limit the option to freeze one's own eggs anyway. The discussions anticipated the removal of this prohibition in relation to the change in the regulation in order to allow PGD.

Regarding these many uncertainties, an invited foreign speaker recalled that egg freezing is not an insurance for motherhood and that there is no guarantee for a child. She added then that it is very hard for women to accept these uncertainties: "They want certainty and they find less than a guarantee", she said, explaining why counselling is important. One way of dealing with these uncertainties is to turn to data from egg donation program which display very good success rates with the idea that they should be similar to a donation to oneself, while keeping in mind that donors are usually aged between 25 and 30, while egg freezers tend to be older. Two other kinds of risks associated with the future of the technology were mentioned and discussed: firstly, the risk of malformations or problems in the children conceived with thawed oocytes, and secondly, the risk that people would prefer to turn to technology than to have sex in order to have a child. The latter is the symbol of a society where the production of children would be entirely in the hands of biotechnologies and doctors, in other words a future of reproduction where it would be medicalized and technologized to the extent that it would become the dominant model.

A second important topic was discussed which is the reconciliation of the legal regulation and the possibility of integrating "social" oocyte cryopreservation in medical practices. As the legal framework explicitly restricts access to medically diagnosed cases of infertility, a central question in the debate was how a technology targeting healthy women could possibly be included in the frame of reproductive medicine. The solution, which was discussed and proposed, is to draw on the temporal gap separating the two key steps of the procedure: oocytes retrieval and cryopreservation, and frozen oocytes' use. As only the use of frozen oocytes in IVF-ICSI is considered as entering the frame of the regulation, the freezing of oocytes is not considered as problematic, in the sense that women would use them only if and when medically diagnosed with infertility. The retrieval procedure is thus considered as rather belonging to a family planning logic in a way similar to contraception. As a consequence it would not be of real importance for reproductive medicine, and would escape the pathology-centred frame of the law.

At the end of the workshop, an urologist presented the male counterpart of social egg freezing, that is sperm cryopreservation. He showed how the cryopreservation of sperm for so-called social purposes is performed regularly, without any debates on its supposed "social" dimension. He mentioned several examples that are often met in clinical practices: men who travel a lot and are physically hardly present for the conception of a child, the workers who take great risks, and especially professionals of air travel who are exposed to ionizing radiation, intensive sportsmen who take anabolic steroids, and especially those who cycle and motorcycle. In addition, he recalled that in the US all the soldiers who go to war have their sperm frozen, as well as adventurers putting their life at risk. This presentation changed the orientation of the debates and blew some fresh air on them. Suddenly, the debates about the social purpose of egg freezing appeared overrated, as a similar procedure was performed in men without any further public debate.

What struck me in the audience was the gendered dimension of the presentation on social sperm freezing. All the activities enumerated by the urologist were dangerous, risky, and somehow very masculine stereotyped, but men were apparently socially not made to feel guilty about them. In contrast, deciding to turn to egg freezing in anticipation of age-related infertility appeared in the discussions as a possible solution, but in need of careful reflection about its ethical, medical, and social dimensions. This indicates how the cautiousness characterizing the regulation of ARTs towards the possibility of medically assisting female fertility might be gendered, and confirm that women's bodies constitute a privileged site of biopolitical control (Krause and De Zordo 2012).

The discussions during this one-afternoon workshop are part of an ethical boundary-work performed by experts in the field of reproductive medicine, characterized by its temporal tension turned towards the future. The many topics discussed show how these experts negotiate the ethical boundaries of their activities, in relation to practices done in other countries, as well as how they try to find practical solutions to the integration of "social" oocyte vitrification in their medical practices and their legal regulation. While the many uncertainties associated with the future of the procedure are pointed out and justify the attitude of cautiousness adopted by medical experts, they are also put into perspective by drawing on actual "facts", taken from egg donation programs for example. The careful ethical-boundary negotiations provided room for the ambivalence towards the future of reproduction in Switzerland, and the place ARTs may play in it. It also enabled the integration of the procedure into current practices, while repeating the importance of ethics and the concern for limits crucial to the maintenance of the good public image of reproductive medicine practitioners as ethical.

Intermediary remarks

By exploring how the idiom of potentiality is used in the discussions and debates regarding the possible authorization of egg donation and integration of egg freezing into medical practices, I have characterized a mode of governance of ARTs that is inscribed in a regime of cautiousness. Egg donation is inscribed in such regime through the past and the importance of ethics. It is inhabited by the fears of the past towards potential abuses that are still active in the present as revealed in the cautious attitude of not asking too much in anticipation of a negative reaction of the Swiss people leading to a step backwards. Rather than hope, it is in the name of a more ethical future that changes in the regulation are asked for, but also that unethical futures are resisted. The drawing of a line between what is ethical and what is not, what is desirable from an ethical point of view and what is not, is the result of the constant ethical boundary-work (Wainwright et al. 2006) performed by the doctors working in reproductive medicine, allowing them to resist the bad figure of "sorcerer's apprentices" going too far. This work characterizes their cautious attitude where the potential of bringing positive transformations, as well as negative, are carefully measured and discussed.

The second procedure, egg vitrification, is inscribed in a regime of cautiousness through the stress of uncertainties at technological, medical and social levels, and the fear of creating "false hopes". Both "actual" and "potential risks" are mobilized to defend a cautious wait for future answers. However, the anticipatory dimension of the egg freezing procedure enables the creation of a distinction with the actual reproductive treatment and thus the performance of it in some centres even though it steps outside of the framework of the pathology upon which the Swiss regulation is based.

This regime is a way of dealing with the ambivalence at the core of the potentiality of ARTs, as a space where both hopes and fears meet. Instead of focusing on the fears, or on the hope, the cautious attitude adopted leads rather to a wait, at the risk of being too restrictive, in order to see what happens elsewhere. The negative dimension of the potentiality of ARTs seems sometimes to predominate, but what is happening is more a decision to observe how the potentialities of these technologies might actualize in other countries, before implementing them, such as in egg donation, or to integrate them, but very cautiously, as is the case with egg freezing. I argue that scrutinizing the temporality of legal changes and especially the way different kinds of imaginary futures are brought into and impact on the present, enables us to highlight how the medically assisted extension of fertility time becomes a matter of governance that goes beyond the

dichotomy between restrictive/liberal regulation, as it provides room for the ambivalence at the core of ARTs potentiality to transform society.

The next chapter will show how the ethical boundary-work performed by medical experts takes as an axis the transformation of the possible nature of reproductive aging that affects the distinction between pathological and social uses at the core of reproductive medicine in Switzerland. It will highlight especially how medical practitioners resist or negotiate the anti-aging dimension of ARTs and how they envision the role of reproductive medicine in the future.

10. Reproductive medicine, anti-aging medicine?

Is the age-related fertility decline a social problem or a medical problem? Is it a pathology in need of medical assistance or a physiological process, a natural part of life that one just has to accept? Should reproductive medicine intervene to overcome reproductive aging and assist the extension of fertility time? If yes, or no, in the name of what value? As biomedical technologies such as *in vitro* fertilization with donated eggs, and egg vitrification, may be used to address medically the so-called problem of "the biological clock" in Switzerland, and therefore to work as anti-aging technologies by extending fertility time, these questions have gained in importance in the reflections of clinicians and practitioners on the role of reproductive medicine.

The previous chapters have highlighted the anti-aging dimension of ARTs and how, under specific conditions, ARTs may work as anti-aging. Chapters 4 and 5 documented the attempts of reproductive biologists to target "aging" and consequently act on it, by substitution in the case of egg donation, or by regeneration, in the case of the mitochondrial transfer procedure opened up by the identification, culture and preservation of oogonial stem cells. They also showed the increasing traffic between anti-aging or regenerative and reproductive sociotechnical projects, as reproductive aging becomes a question of "just" aging. In contrast, Chapter 8 focused on women's experiences of ARTs and showed how some women in their forties actively transform the ineluctability of reproductive aging by turning to egg donation and by de-essentializing and denaturalising chronological age. Those chapters highlighted how by overcoming the biology of reproductive aging through a replacement or regenerative process, some ARTs may transform the ontology of age-related fertility decline. The previous chapter (9) moved to the debates surrounding the medically assisted extension of fertility through egg donation and egg freezing in Switzerland. It characterized the regime of cautiousness at work in the governance of ARTs and of the age-related fertility decline, and highlighted especially the ethical boundary-work of medical experts.

This closing chapter persists with studying this ethical boundary-work by focusing on the frontier between normal and pathological that is questioned particularly by the anti-aging possibilities of egg donation and egg freezing. In this chapter, I want to explore how clinicians and practitioners address the question of the possible transformation of the nature of reproductive aging. Does the possibility of extending female fertility have an impact on their understanding of reproductive aging and how does it affect the way in which they consider the role of reproductive medicine? As the status of age-related infertility is not stable, how do clinicians and practitioners position

themselves towards possible transformations of the object and purpose of reproductive medicine? Clinicians work in a highly biotechnologized environment, but they also work within the framework of the Swiss regulations, which are modelled on the category of "nature" with the underlying principle that only biotechnologies that enable what is possible without biotechnological assistance – or in broader terms "culture" – should be authorized in the realm of reproduction. Therefore I assume that to look at their use of this category can teach us much about both the transformation of reproductive medicine and the limits of female fertility.

10.1. Anti-aging medicine and the distinction between normal and pathological

To think about these questions I turn to the work of social scientists on anti-aging medicine, who have shown how the question of knowing whether aging is a natural process or a disease is at the core of the "biomedicalization" (Clarke et al. 2010) of aging (Lafontaine 2015). The term "ageism" or "the systematic stereotyping of and discrimination against people because they are old", was coined by Robert Butler in 1968 by analogy with sexism and racism in order to point to the stigmatization and devaluing of aging people on the basis of some biological "difference" in our youth-oriented societies (Butler 1989: 139). Hence a crucial question is to what extent anti-aging products and technologies contribute to reinforcing ageist assumptions or on the contrary to resist them. For some scholars, by defining aging as an illness in need of medical intervention, biogerontology would reinforce the negative construction of aging as a "biological failure" and associated ageist assumptions, tending to make invisible or devalue other possibilities of successful aging (Cardona 2008; Vincent 2006). In addition, through the redefinition of aging as an illness that can be cured and possibly prevented by the appropriate consumption of products and lifestyle choices, anti-aging medicine would make the burden of aging lie at the door of each individual in line with a neoliberal model of governance (Cardona 2008; Higgs et al. 2009).

For other scholars, the question of knowing whether or not aging is a disease increasingly loses its relevance. As US-based anti-aging advocates consider that aging is a biological universal process, and not a disease, they do not aim to cure it, but work instead towards its optimization rendered possible by its knowability (Mykytyn 2008). Therefore the classical distinction between normal and pathological (Canguilhem 1966) becomes less relevant because speaking about aging as a disease does not make sense for these proponents. In addition the category of nature itself is reworked by the establishment of a hierarchy of nature that " ranks the human drive to overcome biological constraints as more definitive of humanness than the natural process of aging",

entailing that it is "more natural to pursue anti-aging than to regard aging as natural and only attends to its 'associated' diseases" (Mykytyn 2008: 320).

In addition, the rise of biogerontology is associated with the notion of "functional age" as an alternative to chronological age and centred on separated organs' functioning and measurement (Katz and Marshall 2004). It entails that the classical binary normal/pathological pairing tends to be replaced by that of functional/dysfunctional, which entails a renegotiation of the boundaries between the natural and the cultural. If traditionally, "the family of concepts clustered around the natural – life, health, fitness, normativity, the body, aging – shored up its ontological certainties by signifying nature as that which could *not* be changed, manufactured, or reversed" (Katz and Marshall 2004: 54), nowadays the natural is increasingly culturalized (see also Franklin 2013a; Rabinow 2010; Rose 2007) and therefore conventional boundaries between the real and the artificial or the human and the instrumental become increasingly blurred (Katz and Marshall 2004).

This chapter is about how the categories of "natural" and "normal", as emic terms, are constructed and used in reproductive clinicians' and practitioners' positioning and justifications. While I could observe the importance of functionality and optimization at a scientific level (see Chapters 3 and 4), at a clinical level in the Swiss context the question of the nature and normality of the age-related fertility decline, in regard to the role of reproductive medicine, is still very much discussed. As egg donation may be authorized in future, and egg vitrification integrated into clinical practices, as documented in Chapter 9, the possibility of medically assisting the extension of female fertility prompts clinicians to think about what grounds fertility limits, if not a fixed and determining biology.

The chapter is divided into two parts. The first and shorter part shows how age-related infertility is constructed as a "fact of life" (Strathern 1992a; Strathern 1992b) structuring gender and intergenerational relations in order to make understandable the resistance of clinicians and practitioners towards its transformation and possible associated changes in the role of reproductive medicine. More precisely, it will highlight how the age limits of motherhood are thought of in the context of the interpretation of the legal regulation. The second part moves to study three doctor's positioning on the possible anti-aging work of reproductive technologies and examines how limits between several binary dichotomies such as nature/society, normal/pathological, natural/artificial, voluntary/involuntary or passive/active are negotiated and articulated in different ways.

10.2. Age limits

10.2.1. Age-related infertility as a "fact of life"

Anthropologists working on ARTs have highlighted the importance of "the facts of life" – the biological presumably immutable facts of human reproduction such as "birth and procreation, the inheritance of genetic material, the developmental stages through which a child progresses" (Strathern 1992b: 17) in the structuring of kinship and gender relations. These taken-for-granted facts that seem to lie prior to everything else provide the basis for cultural arrangements thought of as mutable. Yet the development and increased use of ARTs has contributed to transform the conception of nature as the grounding function of these facts of life. As reproduction has increasingly become understood as an achievement (Franklin 1997), the "facts of life have become more visibly partial and contingent" (Franklin 1998: 106) and "transformed from a presumed (universal, self-evident, biological and scientific) certainty into an occasion to reveal what certainty has obscured" (Franklin 1997: 13).

The way in which clinicians speak about the age-related fertility decline in women makes me argue that it is included among these facts of life, as the following short quotations show:

> *The biological clock, if one can say that it applies to somebody, it applies to women, it is unfair, but it's the way it is (Dr. D. 03.02.2012).*

> *So you know that natural fertility decreases dramatically, you see that women over 45, the probability out of 1000 women after one year, 25 get pregnant, and when they are pregnant, they have 95% chances of undergoing a miscarriage. So this is Nature. […] A small injustice between men and women (Dr. A. 05.12.2012).*

> *The fact that women's age impacts the easiness with which one will obtain a pregnancy, this is not something we can change. Nature says it is so and I think that if Nature says so, it is because the woman who must carry the pregnancy, the older she is, the more at risk of complications she is too (Dr. C. 10.01.2012).*

In these short excerpts from interviews with clinicians several aspects of the age-related fertility decline are asserted: it is part of an order of things, or Nature, that includes a specific difference between men and women. Indeed the age-related fertility decline in women is considered as a specificity of female bodies, and thus is used to differentiate men and women, or in other words,

it produces differences relations between men and women. As the taken-for-granted facts that men have a penis and women an uterus, the difference in the duration of male and female fertility, one supposedly ageless (Löwy 2009), and the other limited, declining and incompatible with aging (Löwy 2009), are understood as one of the basic facts of life, part of a Natural order. The shining proof of this fact is that the menopause, as separating the reproductive and non-reproductive parts of women's lives, is thought of as a universal phenomenon. Whatever one does, female gametes reach exhaustion and women enter the menopause around age 50. I found this idea very present in spite of the reported difficulty in objectifying the state of the ovarian reserve documented in Chapter 6, and of the noticing of a grey area, where the moment when the decline becomes steeper and the age at which IVF does not work any longer both remain vague and dependent on important individual variations.

In addition, age-related infertility is framed as an element that standard IVF cannot do anything about, as can be seen in this quotation:

> *Of course, one can get pregnant spontaneously at 45, but it is an extreme minority, and medicine does not have any answer for that, because the problem is oocyte quality, and oocyte quality is directly related to age, and there is no treatment that is going to improve it (Dr. B. 25.01.2012).*

Reproductive aging in women is thus constituted as an obstacle to the success of ARTs, which is the making of healthy children, parents and families, in contrast to the efforts of scientists to find a way of acting on the aging process in the cell itself in order to slow it down or even reverse it. The positioning of age-related infertility out of the scope of action of IVF[130] reinforces its status as a taken-for-granted and real fact of life and an understanding of nature as what happens outside of biomedical intervention.

This specific understanding of "nature" echoes the one upon which the Swiss regulation of ARTs is based, where the ban on egg donation is justified by the wish to preserve the unity of the maternal function according to the Roman Law principle *mater semper certa est* (Manaï 2008) in the name of the wellbeing of the child, the principle at the core of the RMA. The logic on which it is based is that ARTs must imitate "nature" but not substitute it, resulting in the ban of technologies which might enable the creation of relationships that would not be possible without medical assistance (Engeli 2010). Therefore the ban of egg donation is to be understood in relation to the dominant representation of motherhood as not dividable between its genetic,

[130] IVF with the use of the gametes of the couple, not donated eggs, which is prohibited in Switzerland.

gestational, and nurturing (also called social) functions. In contrast fatherhood can be divided and is considered to be uncertain by "nature". The prohibition of egg donation thus consecrates gender differences in relation to reproduction (Engeli 2010), but also a specific understanding of Nature as that which would happen without biomedical intervention.

What is paradoxical is that the will to imitate Nature underlying Swiss regulation, and framing clinicians' reflections, is inscribed in a highly technological environment where in fact ARTs "go against Nature", if we use the terms of the debate, as they aim to palliate or remedy a state of infertility that is somehow naturally there. Therefore, we can observe that under some conditions ARTs are considered as departing from natural paths, and therefore as undesirable interventions, while under other conditions their intervention is considered as legitimate because they are supporting nature. How do clinicians draw the line between one case and the other? How is the frontier (Franklin 2013a) of nature established? How do clinicians justify that in some cases this frontier must be conquered and in some others, must stay untouched?

While the biology of reproduction becomes increasingly flexible and malleable, and open to multiple recombinations and derivations, the use of the category of nature to talk about the pure facts of biology as if they existed 'out there' becomes increasingly problematic. However, it is still very much in use and I want to explore the specific meanings which this category has in the Swiss context of reproductive medicine. If age-related infertility is framed as a fact of life, what happens when some ARTs promise to overcome it by a replacement or a freezing process? And how is the category of nature challenged and transformed when reproductive medicine tends to transform into anti-aging medicine? A first answer is that it produces a need for limits expressed at several levels, and to which I would like to turn now.

10.2.2. The biological limits of fertility, the age limit of motherhood?

While the science of reproductive aging shows that there is no clear-cut age limit to female fertility, but rather an ongoing decline process, the idiom of limits, frontiers, or boundaries is much used to speak about age in relation to fertility and ARTs. As an example, this emblematic question "How old is too old?" is the title of a medical article published in 2004, in the New England Journal of Medicine by Heffner, an obstetrician-gynaecologist in Boston (Heffner 2004), and another common formulation of it: "Late pregnancy: is there an age limit?[131]", is the heading of a short article published in the women's magazine Marie-Claire (Wascowiski 2012) which

[131] Original title: "Grossesse tardive: Y-a-t-il un âge limite?". Translated by the author.

comments on the case of a Swiss 66 year-old single woman having given birth to twins in 2012. More dramatically, in 2012 an Italian case was reported in the media of a child born after IVF with donated eggs abroad was removed from his parents after a long legal battle because they were considered to be too old to take care of him (Gulino and Pacchiarotti 2012). Underlying these short examples is an interrogation about the age limits – whether biological, medical, realistic, social, ethical, legal, recommended, or desirable – of motherhood especially, but also of parenthood, in the context of ARTs.

In order to understand the specificity of the Swiss context regarding the biopolitics of reproductive aging, it is necessary to say a few additional words about the regulation of age in regard to the making of parents through ARTs. There is no definite and explicit age limits restricting access to ARTs in the RMA, but Article 3.b. states nevertheless that "ARTs may be used in couples who, on the basis of their age and personal circumstances, are likely to be able to care for and bring up the child until it reaches the age of majority" thus leaving a certain room for manoeuver to clinicians. Underlying this statement is the desire to protect the wellbeing of the child which is apparently threatened by older parenthood. Formulated in a gender neutral way and addressing "couples", the statement rests on a logic of intergenerational relations, where parents have to take care financially, physically, emotionally, of their progeny at least until the latters' age of majority (18 in Switzerland).

In the comment accompanying the project of the law that was submitted to popular vote, it is however specified that since egg donation is prohibited, there is no need to establish explicit age limits for motherhood:

> *The project does not include any determined age limit. On the one hand, to set such a limit contains the danger that it might be interpreted as a right to benefit from treatment and that the latter would be performed as long as the threshold limit of age had not been reached. On the other hand, to prohibit a person from accessing some reproductive technology on the ground that she has exceeded the legal age limit by one or several days is not satisfying. A strict limit incites the evasion of the law. The preference must be given to a solution consisting of letting the National Ethics Committee clarify the article 3, line 2, letter b, in a Directive. In addition, menopause fixes a natural limit with regards to women, as ova donation is prohibited (art.4). This limit may vary from one woman to another, in such a way that relatively great*

differences between the age limits in the general population may exist (Delamuraz and Couchepin 1996: 245).[132]

Doing so, women's age limits are individualized: it is acknowledged that the biological norms of reproductive aging can be highly variable in the population and we can observe a refusal to set arbitrary age limits. They are also naturalized, as there is no need to regulate them when biology, as the universal fact of menopause, is in charge. In contrast, the age limits of fatherhood are implicitly uniquely thought of in regard to the legal obligation to take care and bring up the child until its majority. Thus, through the prohibition of egg donation the naturalness of the non-division of age and female fertility, in contrast with the legal definition of fatherhood in relation to the ability to take care and bring up the child, are reinforced.

The logic underlying this explanation establishes equivalence between the biological limits of fertility and the age limit of motherhood. Consequently, the possibility of medically extending female fertility raised the prospect of ageless motherhood that would exceed the framework of the law, which is unwanted. The link between biological and motherhood age limits is naturalized and essentialized in a way that enables the setting of age limits to motherhood quite different to those of men. In one sense legal, ethical and biological limits merge together, thus producing an unquestioned strong frontier to the medically assisted extension of female fertility.

In clinical practices, this logic is more or less followed to the letter, but as the regulations remain imprecise to some extent and therefore open to interpretation, clinicians and practitioners also show some room for manoeuver in their concrete application of the law. The first excerpt comes from a discussion with a clinician whom I met in his office in a private centre for reproductive medicine in the French part of Switzerland. He says:

In our centre, we have adopted an internal limit, which is 45. Yes, 45, because after 45, it is not physiological any more. I would say, a 38 years old woman, who has a premature ovarian failure, I would say that it is a disease and this disease means that she cannot have a child. Consequently yes, we should help her. After 45, one considers that it is not reasonable. Concerning men, we have fixed a limit of 60 to

[132] In french: "Le projet ne contient pas une limite d'âge déterminée. D'une part, la fixation d'une telle limite renferme le danger qu'elle soit interprétée comme un droit à bénéficier d'un traitement et que celui-ci soit régulièrement effectué aussi longtemps que le seuil d'âge limite ne serait pas atteint. D'autre part, interdire l'accès à une méthode de PMA à une personne pour le motif qu'elle a dépassé d'un jour ou de quelque jours la limite d'âge légale n'est pas satisfaisant. Une limite stricte incite à éluder la loi. Il faut donner la préférence à la solution consistant à laisser la Commission nationale d'éthique clarifier l'article 3, 2e alinéa, lettre b; dans une directive. Au surplus, la ménopause fixe une limite naturelle en ce qui concerne les femmes, puisque le don d'ovules est interdit (art. 4). Cette limite peut varier d'une femme à l'autre, de telle sorte qu'il existe une relativement grande différence entre les âges limites au sein de la population". Translated by the author.

treatments. Why sixty? Because the law states that the child has the right to have a father up to age eighteen, then we took the average life expectancy of men, which is 78, we removed 18 and we obtained 60. Thus it is totally arbitrary and it is like the limit age of 45 in our centre. But we consider that it is normal and seems logical to us. […] Well, a women getting pregnant after 42 is an exception all the same. And medically, we have much more risks related to pregnancy (Dr. D. 03.02.2012).

In this quotation, we can observe the notion that under a certain age – in the quotation 45 – the decline is considered pathological and in need of medical help, while after this limit it turns out to be physiological and not open to medical intervention any more. The binary between normal and pathological is activated to set a limit determining up to which age women should be treated or their access to ARTs refused. I found the same logic in several centres, even though the exact age marking the frontier between "physiology" and "disease" varies and therefore is subject to some flexibility in practice.

Another interesting aspect that can be observed in this quotation is how the gender-neutral statement of the regulations focusing on "couples" is transformed into the assertion that "the child has the right to have a father" which is technically more accurate. In contrast to the idea of ageless masculinity (Löwy 2009), here fatherhood through ARTs is also limited, if not by biology, then by the legal requirement to take care of the possible child-to-be. The ambivalence of applying the law and having some decision-making power is also revealed in this excerpt where both the arbitrariness and the normality of the politics of access of the centre are recognized. Setting age limits seems normal or taken-for-granted to this clinician while he recognizes at the same time that they are arbitrary.

A similar logic of applying the law can be seen in the following excerpt of an interview with a clinician working in private practice about the age limits of motherhood and fatherhood:

To have a child at 54 or 55, that means that the child will reach majority at 18, which means that 54 plus 18 makes 72, to be 72 years old, even assuming that the pregnancy goes well, that there is no health problem, it will be difficult nevertheless. There are grandmothers who take care of their grandchildren, this is true. There are parents who die and grandparents who take care of the grandchildren, this is true. But it is not something Nature has been programmed for. It will be of interest for you to know that we are not allowed to treat couples, in which the man… you know that life expectancy for men, up to day, is 76, so this means that the husband does not have the right to be older than 58 at the birth of his children, if they are conceived with the help of reproductive medicine. All this is adaptable, because if we take a man who

is 55 and smokes two packets of cigarettes each day, and does not do any sports, we will not treat him either, because the spirit of the Law is that we must guarantee parents until the child's majority (Dr. A. 05.12.2011).

Here the logic of the law based on the obligation to take care of the child until its majority is applied to the possibility of medically assisting the extension of female fertility. While the possibility of circumventing the biology of reproductive aging is envisioned, what is strongly reasserted is the intergenerational order characterized by its linearity and the special place that women hold in the descending flow of care between generations. This order or "program" is naturalized in a way that justifies the setting of age limits to motherhood, even if fertility might be extended, in order not to trouble it. In parallel, fathers are submitted to the same legal requirement of parental responsibility towards the well-being of the child dictating the setting of age limits. In this interview excerpt fathers are even used to justify the need for age limits and the intergenerational natural order.

Two additional elements are relevant in the explanation of this clinician's perspective. Firstly, in contrast with the first example, he stresses the "adaptability" of the limits differentiating between the "spirit of the law" and its letter. If the prevailing logic is the intergenerational obligation to care for the progeny, then more than chronological age, life expectancy should matter and consequently any behaviour seriously threatening health, such as smoking, should be taken into consideration. This example highlights how clinicians have some room for manoeuver in their interpretation but also points to the range of possible practices and behaviours that might be taken into account if this logic takes over chronological age. Indeed, more than chronological age itself, it is life expectancy that would determine the setting of age limits, entailing that aging and its effect on a general state of health in general, and thus anti-aging technologies, and not reproductive aging in particular, might become a determining factor in the reflections on age limits to motherhood, as already observed by the ethicists Bittner and Eichinger (2010).

Secondly, we can observe a shift towards medical responsibility regarding the possibility of having a child. When the practitioner stresses that "we must guarantee parents until the child's majority" we can observe the endorsement of the regulations to the extent that they – "we", the collective of reproductive medicine practitioners – feel collectively responsible for the future of the child. This sense of responsibility is justified by the biotechnological intervention entailing the participation of a third party – clinicians, biologists, nurses, counsellors – in human reproductive processes. The underlying logic is that as long as a couple conceives "naturally" in the sense of

without medical assistance, then no limitation can be imposed as long as it works, but as soon as reproductive medicine intervenes, the natural and private act of conception becomes open to ethical reflections and negotiations about what is the right thing to do. In other words the possibility of having a child submits to the discussions and negotiations of ARTs professionals in their interpretation of the legal regulation, making the act of having a child open to the decisions of experts. Therefore it is very important to understand what is at stake and what underlies the justifications and positioning of clinicians and practitioners towards the setting of age limits.

The shift from the notion of a "natural" conception supposedly without any medical intervention and the "medically assisted conception" taking place in the space of the clinic and entailing a collective negotiation of what is right to do, is well expressed in the following quotation from a biologist whom I met in a large private centre:

> *According to the law, if they do it on their own at home and we do not intervene, they manage to do it, then it is none of my business, but as a third party intervening, the law is very clear, it is the well-being of the child that comes first and the couple must be able to raise the child until its majority. So if you take the man, he dies at 78 or 79, therefore you have a limit at 60 or 61, that we try to respect. This is the limit we set, but then we discuss, and sometimes clinicians say, yes well it is the Brazilian culture or something else, the child will be cared for. We do not treat men who are going to die either (Dr. H. 20.02.2012).*

In this last quotation again the law is applied to the letter. But the biologist stresses also that there are discussions and negotiations about when access to ARTs should be granted. In this room for negotiation, he mentions two alternative logics that may be used to set age limits restricting access. On the one hand we can identify the same argument as above, which is the life expectancy of men. Rather than chronological age, the number of years potentially lying ahead, is what matters. On the other hand, he mentions a culturalist argument entailing that in other cultures – here Brazilian, but I have also heard examples on patients from Africa, especially North and West – other family arrangements take place and so the importance of age might be minor. The example I most often heard concerns an older man with a young woman from "another culture", couples for which the importance of age in regard to the obligation to take care of children loses its importance since a community of possible relatives is thought of as potentially taking over the caring role of the child and supporting the young mother in her tasks, where the father was failing or lacking. This example highlights the extent to which age limits for men, thought of in relation to the obligation to take care of the child, depends much on cultural

familial arrangements and are thus more culturally variable, than the biology of reproductive aging, thought of as a universal and natural fact of life and used to naturalize the age limit of motherhood[133].

This section has shown how biological, legal, and ethical domains articulate to set age limits that are thought of as natural and normal. Especially it has shown how in Switzerland the biology of the end of female fertility as a fact of life is equated with the age limits of motherhood. In contrast, the age of fatherhood is limited by an intergenerational logic of care for the child. The excerpts of interviews have additionally highlighted the room for manoeuver of clinicians in the restriction of access to ARTs in respect to age. While on the one side they apply the law to the letter, on the other they mobilize other justifications associated with chronological age, the life expectancy and a culturalist assumption. This reveals the extent to which the age limits of parenthood that are thought of as normal and natural, are inscribed in the western genealogical and kinship model (Bamford and Leach 2009; Schneider 1980) where motherhood is defined in biological terms, while fatherhood is rather defined in legal terms.

10.3. The shifting boundaries of normal and pathological

To explore further how the distinction between the two categories of normal and pathological is understood and negotiated, I now turn to three kinds of justifications underlying it. Each position is associated with a specific clinician or practitioner whom I met, but they could of course be identified in others persons. I choose to present these positions more deeply because they articulate in different ways the role of reproductive medicine towards the limits of fertility and motherhood that challenge the boundary between normal and pathological.

10.3.1. TREATING DISEASE, REESTABLISHING NORMALITY

The first position is the one most in line with the legal regulation. I will draw on the rich discussion with Dr. A. to illustrate the specificity of this position. He explains to me how the decision to intervene with ARTs should be taken, by drawing on several exemplary invented "borderline cases" as he calls them. How to know exactly when age-related infertility is a medical

[133] In the interviews with clinicians, there was no mention of other alternative family configurations where intergenerational relationships would be configured differently. The designation of the "other cultures" (where other family organizations and practices prevail) can be read as a way of reaffirming a Swiss identity based on a specific family model. However, further research is needed on the many forms of families in Switzerland in order to show if there are other intergenerational orders in Switzerland, and if yes, in which kind of family and configurations, and how the prevailing kinship model based on the universality of intergenerational relationships is negotiated. For further reflections on Swissness, whiteness, and family relationships, see the work of Anne Lavanchy (e.g. Lavanchy 2015).

condition and when it becomes a normal process? Of course, the answer is not easy at all and much of the work performed by doctors consists in negotiating this boundary. In a very instructive way he presents cases enabling me to understand how his logic is at work. These cases highlight interestingly the room for manoeuver of doctors and how when doctors have to decide to restrict access to some persons they transform themselves into ethicists, weighing the pros and cons and deciding eventually on what is fair and unfair. Here are two of his examples:

> *I take a sensitive example, which is the daily bread of the clinician. It is a couple, she is 44 years old and he is, whatever, 28 for example, but he has semen of disastrous quality. Because of his sperm problem the couple should undergo IVF. Yet the pregnancy rates in IVF with the oocytes of this woman fall to zero from age 43. There is no pregnancy brought to term. Ok there are exceptions, but anecdotally, and in principle, many centres set a limit at 43 and I, personally, don't do any IVF for somebody who's older than 43, because it just does not work, so I won't draw people down a path where they will spend energy, hope, and money for something that won't work. I find it unfair. But the problem is that this woman cannot do any IVF because she is too old and he cannot have any children because his sperm is too bad. It is typically a couple, perhaps if she had a husband who had sperm of wonderful quality, she would have children, and if he had a younger wife, then he could undergo IVF and they would have children. So from time to time there are unfortunate relationships. So should egg donation be considered in cases like this one? I would rather say no, because… it is a subtle reasoning, he has the right to do IVF, but she cannot do it because she is too old, it is not because she is ill, it is a borderline situation, a limit situation (Dr. A. 05.12.2011).*

This case illustrates some of the reasons why the doctor would refuse access to egg donation to this couple. Several elements can be observed that reveal how the role of reproductive medicine towards the biology of age-related infertility and possible associated age limits is envisioned when taking into account the prospect of overcoming these limits through egg donation. Firstly we can observe the importance of the couple in the production of infertility. As already documented, in reproductive medicine the couple becomes the relevant unit of medical care (Van der Ploeg 1999). It is their unfortunate being together that makes both individuals infertile. As very well expressed by the doctor if they both had another partner then they would probably be able to have children. It is through their being a couple that the woman's age becomes an obstacle to having a child for both of them (see also Bühler et al. 2015). The importance of the couple as the unit of treatment complicates the ethical reflection when the question of access is at stake, as it questions whose individual's rights should be prioritized.

A second element is related to the ban on egg donation entailing that only IVF with one's own oocytes is possible. As statistically, success rates drop with age, IVF with one's own eggs becomes a medical solution that is not efficient. Instead of restricting access based on the arbitrary age limit of 43, the practitioner explains how the refusal to perform IVF responds rather to an ethical concern of not encouraging people to turn to a treatment when there is (almost) no chance that it would work. A concern for transparency and for not giving false hopes to the couple justifies this decision not to do IVF in a woman over 43.

In contrast, when it comes to the possibility of using donated eggs, another logic is at work. The distinction between normal and pathological is used to make the practitioner decide that access to egg donation should not be allowed in this case due to the fact that the only problem of the patient is that she is too old and not ill. In this logic, it is not the suffering, desire or intent of the couple, nor his medical condition that prevails, but the fact that age cannot be considered as an illness necessitating a medical intervention. This case illustrates how the pathology-centred framework that is present in the regulations frames the reflections of this doctor. However, at no time does he show much certainty in his decision and stresses rather that he is hesitating, that it is not easy to know what to do and that he is aware that another decision could be made. He shows how thin is the boundary between age-related infertility as a pathology in need of medical intervention, and as a physiological process entailing that medicine should not intervene.

To contrast the first case, he presents to me a second case, where another logic is at work, in spite of some similarity:

> *There would be another borderline situation. A woman comes to see me with her husband. She is 35, we investigate and we see that her tubes are totally blocked, or rather 38, she is 38, to be more demonstrative. She hasn't seen a gynaecologist for a while, so I do a full medical examination, we think that she would need IVF because her tubes are irreparable, and when examining her I find a lump in the breast and we investigate and it is cancer. We treat her cancer and the physicians who treat her say that she has to wait for five more years before starting a pregnancy, because it is too risky now, five years later she will be 43, she will not be not eligible for IVF any more. This is also ethically sensitive. I have no answer to this question, I don't know. I think I would say yes, but I start taking myself for God in person, if I have the right to decide what is fair and unfair, I am not the King Solomon (Dr. A. 05.12.2012).*

The second case exposes the similar situation of a 43 years old woman who would need donated eggs in order to achieve a pregnancy. While in the first case, the doctor would have refused

access in the name of the physiology of reproductive aging, here he would tend to say yes. While rationalizing his decision-making and trying to explain to me the logic of his reasoning, he also recognizes the arbitrariness of his judgment where his personal affinities or subjective sympathies may enter and make the balance weigh more on one side or the other. He clearly states that this kind of decision grants him too much power, which he finds problematic. Whatever the problem of this possibility for judgment, I think that it is not an exception and that it is exactly this zone of uncertainty, of indecision, that highlights how social norms and categories are at play, revealing so much more than the clinician's personal opinions.

We can identify two elements impacting on his decision. Firstly, the fact that this woman initially wanted a child at age 38, that is considered by this doctor as an age at which a medical intervention is legitimate. Secondly, the fact that she had cancer makes this woman enter the category of patients suffering from a medical condition for which they are not considered responsible. Even though her age is problematic from the point of view of IVF success rates, like in the first case, here the fact that she had cancer dominates the reflection. Therefore, we can see the emergence of an economy of responsibility associated with the pathology/normal binary. This economy is explicitly at work in a third case presented by the practitioner discussing the possibility of freezing one's own oocytes:

> *Dr. A.: In principle I am against [egg freezing in prevention of age-related infertility that is not related to medical reasons such as cancer], but I have done it in exceptional situations. I did it for example for a young woman who was leaving for a humanitarian mission and who could really not be pregnant during three years. In addition, she came from a country where it was possible to do it, so I accepted, but it is totally exceptional, because basically I find this ridiculous. You might be shocked, but I have the feeling that in life everything takes place in its own time. I started to play violoncello at age 34, I will never play well, and I would love an additional neuron to be implanted in my brain to let me play better, I would love to, but I accept that it is not possible, I started to play too late.*
>
> *NB: Is the idea that there simply are limits in life that we have to accept and…*
>
> *Dr. A.: Yes, but the point of reference must be the highest number*
>
> *NB: The norm?*

Dr. A.: Yes the norm, but also to go on a mission is a noble motive, while to accept a Chief Executive Officer position in a bank is not a noble motive, but to think this way is not good I suspect. (Dr. A. 05.12.2011).

This third case is interesting because the medical intervention is clearly not driven by a medical cause. It is a preventive act of age-related infertility but the reason why the doctor thinks a medical intervention is legitimate is because of the "noble motive" leading to the woman delaying childbirth, in contrast to a career goal that is not considered to be noble enough to justify a medical intervention. Here clearly a moral hierarchy between reasons leading to postpone childbirth and turn to egg freezing to prevent the effects of aging on fertility is at work, so that a medical act considered as "ridiculous" by the doctor turns out to be legitimate enough due to the moral superiority of this woman's motivations. While displaced to the field of prevention and anticipation, rather than in the catch-up logic of egg donation, the pathology/normal binary is here replaced by a distinction in the nature of the causes leading to the need for ARTs to have a child: noble, generous, altruistic, or selfish and career-oriented.

This "exceptional" case is used by the doctor to put in perspective his more general stance towards the possibility of extending female fertility through egg freezing. The exceptionality of this case allows him to stress that in general he is opposed to the possibility of freezing eggs. He bases this opinion on the idea that "everything takes places in its own time" and that one needs to accept that sometimes it is too late to do something in contrast with the personal wish that this order would be different. The comparison with playing violoncello is used to stress that some activities or skills cannot be acquired, that for various reasons it is "too late", and that there is no reversal or catching up to the linearity of chronological time and the order of life.

To illustrate his position more clearly, the doctor turns to the example of anti-aging medicine in order to illustrate how he sees the role of reproductive medicine towards age-related infertility:

Dr. A.: If they [the older women turning to egg donation abroad] find people who agree to do it, fine, I cannot do anything to prevent this, but it is not my vision of medicine. There are analogies, for example the aesthetic surgery of aging, I am not in favour of that. I am not speaking about aesthetic surgery in general, because sometimes, there are really important problems for the persons. Again, the boundary is critical. Typically when the aesthetic surgery means removing wrinkles, this kind of things, I am not in favour, it is only my personal opinion, but I think that medicine does not have anything to do with this.

NB: Is it like if one was going beyond some natural limits?

Dr. A: Yes, yes, but no. Sometimes we go beyond a natural limit. That means, an appendicitis, it kills the patient quite often, so we intervene surgically and I think that we are right to do it. A bacterial infection, we give antibiotics, thus we do not let nature takes its course.

NB: Actually even in reproductive medicine in general it is the case.

Dr. A: Exactly, but we can situate, we can define what a disease is. According to my opinion, this is the common denominator. And disease is what deviates from what is happening to everybody. In fact a fifty years old woman, most of the fifty years old women do not have children, therefore medicine should not substitute Nature in this sense (Dr. A. 05.12.2011).

The comparison Dr. A. makes between egg donation enabling the extension of fertility by intervening on reproductive aging and anti-aging aesthetic surgery draws attention to a similar logic at work in both cases. The reference to removing wrinkles makes the medically assisted extension of fertility time as sometimes an unnecessary and superficial intervention, or a luxury procedure, in opposition to "real" medical problems. More than the crossing over of a natural boundary in itself, which is considered perfectly legitimate in many cases, what seems problematic for this doctor is that age-related infertility is not a disease but rather a normal process exceeding the field of reproductive medicine. The way he defines what is pathological as what deviates, from what happens to the majority in a statistical sense, is revealing. Here pathology is not defined as an ontological locus enabling to act on it, neither as a lack of balance between external and internal elements (Canguilhem 1966), but it is defined in regard to what the majority can do. In this sense the role of reproductive medicine is to reestablish the norm in the statistical sense of what the highest number of people can do. This logic becomes even clearer when Dr. A. specifies how he understands the role of reproductive medicine:

I became a doctor in order to cure sick people, to cure disease, not to put myself at the service of social evolution, which now brings us to have children later. I have nothing to do with this. I mean that medicine is not concerned with this. It concerns the way we choose to allocate the different parts of our lives. […] I guess that a woman about 45, 46, 48, who doesn't get pregnant, then it is because of her age. Medicine does not have anything to do with this. […] If a minority cannot do what the majority of women can, it is not fair, so medicine should intervene. […] But it is possible to define what is pathology, this should be the common denominator. Then pathology is what does not affect all the people. Most 50 year-old women do not have children, so medicine should not substitute itself for nature (Dr. A. 05.12.2011).

Here clearly we can see the establishment of a boundary between an age at which most women are infertile and thus reproductive medicine should not intervene, and an age where its intervention is legitimate in order to reestablish the normality of a life course characterized by what most women can do at some age. This boundary articulates with an economy of responsibility that makes some women the victims of an unfair pathology, making them deviate from the norm, while the others are seen as responsible for their individual choice, and its consequences such as infertility. ARTs are seen as tools enabling the reestablishment of the norm of young fertile bodies, but not as allowing them to help older women seen as having to assume the consequences of their individual and selfish choices.

We can therefore see two definitions of infertility, depending on their relation to age, emerge from the position of the doctor. In the first case, infertility is seen as the involuntary consequence of a pathology, which can be genetic or can follow a chemotherapeutical treatment against cancer, in association with young women who are seen as not responsible for what is affecting them. In contrast, in the second case infertility is seen as the result of a social evolution leading to choose to postpone motherhood for selfish (or careerist) reasons. In the first case, the intervention of ARTs is legitimized by the medical duty to repair damages done by disease preventing some women from doing what the majority can do, while in the second one, ARTs are denied in the name of personal choices and social changes which have nothing to do with medicine. Society's transformation conducing women to postpone motherhood putting them at risk for age-related infertility is considered as beyond the scope of the legitimate and ethical action of reproductive medicine.

In this logic the nature of reproductive aging is inseparable from the role of ARTs. As the borderline cases presented by the doctor illustrate, deciding the age limit of access to ARTs is complex and necessitates an intense work of negotiation where ethical uncertainty predominates. However a rather consistent logic emerges from Dr. A. positioning of, where the role of reproductive medicine has more to do with the causes leading to infertility – pathology or age due to the postponement of childbirth – and with a moral economy associated with them, than with the biology of reproductive aging. More than the biology itself, there is the strong idea that ARTs should only intervene in the course of "Nature" to reestablish the norm of fertility in young bodies and not as a catch-up intervention to go against the norm of infertile older bodies. As this last quotation illustrates very well, ARTs have to respect the course of "Nature", understood in the sense of what is normal and of what happens to the majority:

> *There are people who think that we should set an arbitrary limit, but I find it uncomfortable. I think that there are women who get pregnant spontaneously at 48, so very good Nature wanted it so, and there is no reason that medicine should start preventing Nature from working well, when it works well. There are others who do not get pregnant at 38 and this is not normal and I think that we should help them and in these cases an egg donation would be welcome, if it is an oocyte problem (Dr. A. 05.12.2011).*

Nature thus becomes an active force at work in the ethical decision-making of this practitioner about the age limits of motherhood through ARTs. It is a specific nature, a nature beyond the scope of ARTs, only when it meets the norm of older infertile bodies, but not when it is about helping young bodies to meet the norm of fertility. In this sense the naturalness of the strong association between youth and fertility, and aging and infertility, is strengthened and naturalized through the norm of what happens to the majority more than the biology of reproductive aging itself. In addition, the role of reproductive medicine is strictly positioned as supporting the normality of the life course. The specific economy of responsibility at stake entails that only women who are not responsible for their deviation from the norm are taken into consideration, while the ones who are responsible for deviating from the normality of age-related infertility are blamed and see their access to ARTs refused as not legitimate.

10.3.2. Alleviating sufferings and adjusting to society's transformations

The second position is more minor but no less interesting and complex. Two obstetrician-gynaecologists, Dr. B. and Dr. F. working in the private sector and dealing with a mixed population of patients with fertility and general gynaecological problems, illustrate this second position very well. Dr. F. starts by explaining how society's transformations impact on the postponement of childbirth and the associated risk of age-related infertility. She says:

> *One needs a partner, to be in couple, to complete a family project. Fertility rates are higher before 30 but around twenty nobody's ready. It is the price of our emancipation and the price too, is that men are very anxious at having a child, men are brakes, they are not ready before 40 and even after (Dr. F. 02.05.2012).*

In this quotation she highlights how two temporalities are conflicting. The first one is social, that is dictated by the social norms of the heterosexual couple and the emancipation of women. It is not synchronized with the second one which is biological and entails that the best moment to have a child would be in the twenties. Echoing widely spread discourses on the "biological clock", she stresses the conflict between these two temporalities. The biological clock discourse

developed in the seventies (Friese, Becker and Nachtigall 2006) as a consequence of the increasing number of women working and achieving higher educational levels. The main idea conveyed by this discourse is that postponing family building because of higher education and work results in the most fertile years of women being over when they decide to have a child, thus leading to an increase in infertility. By implicitly including herself as a feminist, by using the "we", this practitioner inscribes the "biological clock" discourse in the political battles of – white, middle class and heterosexual – women to access equality with men. In this sense, the postponement of childbirth is seen positively even though it has as an unwanted side effect – "the price to pay" – a higher risk of infertility due to reproductive aging. In addition, this biological clock discourse is inscribed in gender relations where the reproductive calendars of men and women are conflicting (Bessin and Levilain 2012).

In a similar way, Dr. B. also formulates the problem of the biological clock as a conflict between genetically determined limited fertility and social transformations leading women to postpone motherhood:

> *We know that female fertility is maximal between 18 and 30 and that it decreases thereafter, in some women earlier than in others for different reasons. It is a genetic program, so there are our genes, for centuries, and there is our social life that has transformed so much. So we have this optimal fertility during about a decade, between 20 and 30, and therefore women should have children before 30. But obviously, it is not compatible with the life we live nowadays and most young women are not aware or do not want to grasp the problem (Dr. B. 25.01.2012).*

Here the age-related fertility decline is inscribed in the genealogical time (Bouquet 1996) of the passing on of genes with the idea of a fixed and genetically determined biology. In contrast, Dr. B stresses how society has transformed so much, generating a gap between both temporalities which results in an increase in infertility. As for Dr. F. the social transformations which have led to an increased participation of women in studies and work are seen positively. What is added in this quotation and presented as a part of the "biological problem" is the supposed lack of awareness of young women about this gap. Again this echoes public discourses on older parenthood that present the extension of female fertility time as a loosening of age norms, and a denial of the biology of reproductive aging, encouraged by the spread of ARTs (Bessin and Levilain 2012).

Their formulation of the "problem of the biological clock" while reproducing a cliché enables them to develop their own positioning about the possible working of reproductive medicine as anti-aging. These two gynaecologists present their observation that there is a gap between biological and social times, without rejecting these social transformations on the side of what is not the object of medicine, as in the first positioning (Dr. A.). Rather, they both assert that reproductive medicine has to adjust to these transformations. This adjustment can be observed in the two main strategies they envision in order to synchronize biological and social times.

The first one concerns the role of reproductive medicine in the prevention of age-related infertility, while the second deals with the role of reproductive medicine towards the age limits of fertility, and especially the role of egg donation as a catch-up technology. As Dr. F. considers the postponement of childbirth to be the result of "our" emancipation, it is not something she would like women to return to or undo. In a similar way, Dr. B. sees positively the engagement of women in study and work. In short, for both of them, the fact that women postpone childbirth is not seen negatively, it is part of the society we live in, even though it has problematic consequences in terms of fertility. This makes their position towards the prevention of age-related infertility slightly ambiguous in the sense that they would not encourage women to have children earlier in life, but on the other hand they face age-related infertile women in their practice on a daily basis and especially notice that IVF is powerless to help them, and consequently feel the need for prevention.

Both mention that they try to make women more sensitive about the biological limits of fertility. In this sense, their role as gynaecologists is seen as a soft prevention of age-related infertility by providing women with better information about it. But as Dr. B. stresses, this information should not increase women's distress and their social situation regarding the decision to have a child should definitely be taken into account. She explains how she proceeds:

> *I try to make them sensitive but without stressing them, because many of them, it is not that they do not want a child, but it because they are in a personal situation that does not enable them to realize this project. It means that they are not in a stable relationship, or that they had a relatively long-term partner, but that they split up. And it is really tricky to tell them to think about their biological clock, while obviously they do not have the required conditions to realize their motherhood or parenthood project. Thus it is really difficult at that level (Dr. B. 25.01.2012).*

While ideally she thinks that more information on the age-related fertility decline should be publicised, she acknowledges that in practice it would just stress women more, as it is not that they do not want children or are delaying childbirth without thinking about it, it is rather that they are not in the right place to carry out their child project. Her taking into account of the social requirement to have a child entails that the two domains of the social and medical cannot be disentangled. The social "requirements" of the right moment to have a child – stable couple first and work second – are an integral part of her clinical decision not to stress patients with a preventive message that they could not apply anyway. She does not separate them, neither does she think that as a practitioner she should fight against them, she defends rather the necessity of an adjustment to current social norms determining the making of a family and their integration in her clinical judgments.

The second position of these two gynaecologists concerns the role of ARTs towards the biology of reproductive aging. Here is what Dr. B. says about egg donation:

> *Let's say, I think that egg donation has happy days ahead of it, in the sense that by that time we will have solved the problem of society's evolution and women will have realized the problem, and then that we will have reversed the current trend to postpone the making of a family, and that the next generations have children earlier and go on with their careers perhaps after a hiatus, but have their children earlier and study later [which would imply no need for egg donation or freezing]. I think that we are very far from that and therefore there will be an increased demand for egg donation [implying, until the problem of society is solved]. And as such to shut the door completely, I think that it is just not to live with its own time and not to be conscious of what it means (Dr. B. 25.01.2012).*

Without defending egg donation as a perfect "technological fix" (Almeling, Radin and Richardson 2014), nor promoting an ideal ageless fertility, Dr. B. stresses how to reverse society and gender relations between men and women is a utopian goal that might happen one day in a far future, but also might not. Society is seen as open to change, the possibility of a reversal of the current trend to postpone childbirth is imagined, but remains beyond the scope of the individual's actions. As having a hold over society's trends seems illusory and implicitly not reproductive medicine's goal, reproductive medicine practitioners have to adjust to society's transformations, but not to encourage them, because they are part of the world in which one lives. This entails that the distinction between social and medical is blurred, as they cannot be easily separated.

Like Dr. B., Dr. F. also thinks that little can be done about changing society's trend to postpone motherhood. She stresses all the infrastructural difficulties – lack of day care centres, the short duration of the maternity leave, lack of support of men – that makes it hard for women to reconcile work and family in Switzerland. But she goes even further and develops an alternative economy of responsibility to the one of Dr. A. About the age limit up to which Dr. F. thinks reproductive medicine should intervene, she says:

> *Sometimes, women need to be [hormonally] stimulated. I don't close the door, because they will continue to consult anyway, because they need it. At a pinch it would be inhuman. I cannot judge. Even if we present that pregnancy rates are inferior to 5%, if we don't try, they will have the feeling that we are shutting the door (Dr. F. 02.05.2012).*

In this quotation the focus is on the sufferings entailed by involuntary childlessness. If in the position of Dr. A. first presented, the pathology as a bodily and normative dysfunction legitimates medical intervention, here it is the human sufferings that justify the acceptance of beginning a treatment. Independently from the reasons that led to the condition, ARTs are seen as a legitimate tool for alleviating childless women's sufferings in their forties. In this logic, reproductive medicine is seen as potentially helping to bridge the gap between conflicting temporalities, and working as a catch-up tool. Women are not seen as personally responsible for society's transformations and consequently should not be blamed for their infertility. On the contrary they gained much through women's emancipation and thus should not be prevented from accessing ARTs in addition to their suffering.

Instead of turning to the statistics of success rates, Dr. F places her reflection on the "human" emotional level of care, entailing the moral obligation to intervene in the name of giving hope. What justifies medical intervention is the suffering entailed by infertility, and not its status as a pathology. Once a technology can be used, it is unfair not to use it in order to alleviate suffering. She says:

> *Clearly, techniques open the door to situations where we just had to grieve before. But all societies had their transformations. The Romans they had adoption and did a lot to remedy infertility problems. I think that our values are on the move. 20 years ago egg donation initially shocked us, but today... […] Of course what we do is not natural, it has effects, but it is really good that ARTs exist, I mean there are so many children who are well and who are really a joy for their parents, for everybody. It is a great*

possibility. Before, it was really hard, when one lived with infertility, it was very very difficult (Dr. F. 02.05.2012).

In this quotation, what becomes naturalized is society's will to act technically to alleviate the pain generated by infertility, pain which is also naturalised as deriving automatically from the experience of childlessness. Therefore, an ambivalent use of the category of nature can be observed. On the one hand, Dr. F. recognizes that using ARTs is "not natural" as it goes against a state that one had just to accept before, in a time where no technological means were available. On the other, she naturalizes the will to act on the suffering generated by infertility as something that has always existed. In this sense, the distinction between normal and pathological, or social and medical, becomes blurred or no longer relevant.

However and very interestingly, this logic has its own limits as Dr. F. thinks that ARTs should not be used after 50, the symbolic frontier of the menopause. She justifies this limit by turning to the notion of natural fertility and the legal obligation to take care of the child until its majority. She also justifies the setting of a limit by the idea that when reproductive medicine as a third party intervenes, it engages its responsibility towards the potential child. In addition, she mentions the health risks to which older women expose themselves when pregnant after fifty. All these common reasons point to the problems of PM pregnancies.

The positioning of these two gynaecologists does not lead to a defence of the use of ARTs as anti-aging animated by an ideal of ageless fertility. They rather stress the need to set some limits in response to the risk of being taken as a "sorcerer's apprentice". However, they take social transformations into account and present the role of reproductive medicine as having to adjust to them. By displacing the focus on pathology onto the sufferings entailed by childlessness independently from the causes that lead to it, and even more by naturalizing the will to develop sociotechnical arrangements in response to it, they blur the distinction between normal and pathological or social and medical, at least to some extent. In this sense the role of reproductive technologies as anti-aging is legitimized at least until the frontier of the menopause at fifty.

10.3.3. Preserving the intergenerational order and changing society

The third position presents another way of assembling the social and the natural in the making of the limits of fertility and motherhood. Two clinicians, one working in a public hospital and another one having published on the topic personify this specific positioning. I met the first clinician in the reproductive unit where he works. After being mistaken for a patient, I waited for

a moment under the frames displaying pictures of happy and chubby babies, including several pairs of twins, all presumably born by IVF. I was skimming through some articles on folic acid and consumption of alcohol during pregnancy, obesity and infertility, and a newspaper article stating that an increasing number of babies are born through IVF, when Dr. G. invited me warmly to enter her consulting office.

Before I could introduce the goal of my project, he started our discussion by explaining that for him the problem of age is related to the difficulty to reconcile career and children. He explained how women delay motherhood again and again, until it is too late. He deplored the lack of information about the "biological clock" while information on contraception is so well diffused. He emphasised the lack of day care centres and the many infrastructural problems that women have to face when they have children whilst working. Focusing on mother's age, he then explained in detail to me all the risks and health problems related to late pregnancies for the mother and for the baby, such as gestational diabetes, hypertension, pre-eclampsia, intrauterine growth restriction, and prematurity. In this way, he framed late pregnancies as a medical problem, in the sense that women are really at risk, not only of infertility, but of all the age-related pregnancy complications. But he framed it also as a social problem, in the sense that society does not allow women to reconcile both family and career. This combination makes him insist on both the importance of preventing late pregnancies, and not just age-related infertility, by insisting on the better diffusion of information on reproductive aging and infertility, and on the need to change society in order to improve possibilities for a better reconciliation.

This position can also be found in an article published in a Swiss medical journal by another clinician. The article discusses the recent technological possibility of freezing eggs and of preventing age-related infertility by preserving gametes in the state, or at the age, that they were retrieved (Wunder 2013). The article was partially analysed in the previous chapter, but here I focus on the notion of the natural-social boundaries. The author writes:

> *Unfortunately, social freezing is in general not a solution for the underlying societal problems to fit in with professionally active women and having children. It only delays the existing problems. Furthermore, it creates a lot of potential new problems. A great deal more should be undertaken to offer real solutions to the underlying societal problems which are in part: pre-school education, care in the event of childhood illness, and the many weeks of school holidays, acceptance of professionally active women having children, and more job offers with a workload < 100%. Furthermore, society should be informed about the*

decreasing chances of pregnancy with increasing maternal (and paternal) age as well as the increasing risks of miscarriage and obstetric/neonatal complications (Wunder 2013: w13746).

This quotation shows how age-related infertility and the medically-assisted extension of fertility time are thought of as mostly the result of "societal problems". Switzerland is characterised later in the article by its "rigid structures" and its "paternalistic view of the role of the woman in society" (Wunder 2013: w13746) understood as being the root problems. In consequence, rather than multiplying reproductive technologies which might possibly work as anti-aging, this author makes clear that the "real" problem is social, and that a "technological fix" will only delay and even bring more problems. In this sense, she draws a line between the social and medical status of age-related infertility, neither rejecting society out of reproductive medicine's scope of action, as in Dr. A.'s position, nor integrating it and adjusting to it as in Dr. F and B.'s positioning, but rather targeting society as the site where to act if one wants to decrease age-related infertility and late pregnancies.

ARTs may work as anti-aging but will only create problems that should imperatively be avoided. What are these problems? The article focuses on "neonatal and maternal risks of primiparity at an advanced maternal age >= 40 years" and lists all the health problems related to age, but also more generally to the use of IVF-ICSI, and to the lack of information about the outcome of children born after oocyte vitrification. It then develops a second aspect of the question, which is ethical, by weighing the pros and cons of the possibility of freezing eggs and opposing the wellbeing of the child to the reproductive autonomy of women. The insistence on medical risks related to the medically-assisted extension of fertility which would be the result of societal problems, shows how the medical framing of late pregnancies is used to prevent the use of ARTs to delay childbearing. It shows how undesirable is the working of ARTs as anti-aging technologies as they might bring more side effects, risks and problems, than solving the problem. In contrast to the second position (Dr. B. and Dr. F.), this third position denounces the medically assisted extension of fertility time as bringing more negative than positive consequences, instead of alleviating sufferings and giving hope.

It highlights especially how utopian is the goal of egg donation and freezing as catch-up technologies or anticipating technologies of the right moment to have a child. These ARTs will not help to synchronize biological and social times. There is no "ideal time" and from a social point of view having a child will always be complicated. In other words, this clinician denounces the illusory promise of technologically synchronizing times in regard to the possible anti-aging

working of egg donation and freezing, as actually not working and producing more risks than benefits. Consequently it should be avoided.

In addition and included in the ethical aspect appears a concern about trouble in intergenerational relations. One can read:

> *It has also to be considered that grandparents, who nowadays help a lot in looking after their grandchildren during the school holidays or in the case of illness, would be in the case of delayed motherhood (after social freezing) either in a state of health incompatible with the energy of the children, or deceased. It has also to be mentioned that later on, these old parents, will for the same reasons not be able to look after their grandchildren. And it has also not to be forgotten that the resulting children could be very ashamed to have parents who could be perceived as their grandparents, possibly leading to psychological problems (Wunder 2013: w13746).*

This excerpt shows how the medically-assisted extension of fertility time is framed as something to be avoided, not only because of the medical neonatal and obstetrical risks, but also because of the trouble in intergenerational order which it might bring. The flow of care descending the generations might be challenged by the larger gap between them produced by the use of "social egg freezing". Therefore what is resisted in this position concerns the transformations in the continuity of family arrangements. Changing society is desirable as long as it does not trouble the intergenerational order and concerns "only" the place of women in society allowing them to reconcile career and children more easily. ARTs by enabling the extension of female fertility should not transform the intergenerational order, or in other words should not be used to transform society in this respect. Society should be transformed by social means only, and reproductive medicine should not contribute to extending female fertility. In this sense the working of ARTs as anti-aging is strongly resisted, not in the name of pathology, but in the name of the framing of age-related fertility decline as a basically societal problem, and not a medical one.

The will to act on society with social means can be seen in several strategies proposed in order to remedy the problem of age-related infertility in order to prevent the increase in late pregnancies through ARTs. Firstly, the author mentions that "studies around the world have shown that young people are not aware of natural limits of human fertility" and consequently that better information should be diffused to school-children on both the age-related fertility decline and the "increasing risks of miscarriage and obstetrical/neonatal complications" (Wunder 2013: w13746).

Secondly, social structures of the "paternally oriented country of Switzerland" should be transformed, both at an infrastructural level – day-care – and at the representational level of gender roles – for example the fact that "women who have children are often not considered suitable for leadership" (Wunder 2013: w13746). Finally, alliance between political parties and medical societies should be made in order to fight together the societal problem leading to late pregnancies.

This last positioning shows another way of assembling the natural and the social. Instead of rejecting the "social" as an individual problem, such as in Dr. A.'s case, here the social is very collective and engages the society as a whole. It should be transformed in order for women to have more room to reconcile work and family. However, by resisting strongly the medically-assisted extension of fertility, this position also contributes to reinforcing the naturalness of the life course, of the intergenerational order, and of the coupling between youth and fertility[134].

Intermediary remarks

This chapter has shown how for the medical experts whom I met, the limits of fertility are naturalised and essentialized as a fact of life. It has also shown how through the prohibition of egg donation, legal, ethical and biological limits merge together to produce an unquestioned and strongly naturalized frontier to the medically assisted extension of female fertility where the biological limit of fertility equates with the age limit of motherhood. In contrast, the age of fatherhood is also limited, but in relation to the obligation to take care of the child, entailing that life expectancy becomes more important than chronological age.

The analysis of three positionings of practitioners has then shown how, depending on the nature of reproductive aging, different roles for reproductive medicine are envisioned. Three different configurations of the natural and the social in regard to the setting of age limits and the role of reproductive medicine can be identified. The first positioning resists society's transformations and activates a clear distinction between normal and pathological, in association with an economy of responsibility that makes younger women victims of a pathology, while older ones are

[134] I did not meet any doctor fully supporting the medically-assisted extension of female fertility. The doctors I met told me that the extension of fertility through ARTs was an object of contention among them, and my sample being limited, my analysis probably does not account for the whole variety of all existing positionings. All the doctors I met were in the French-speaking part of Switzerland. It is possible that it might be different in the German-speaking part. Especially Dr. Zech, director of the Ovita clinics (http://www.ovita.eu/) would probably have another discourse, as well as the intermediary agency Swixmed (http://www.swixmed.com/). However, I think that it is very difficult in Switzerland, at the present time for medical practitioners, to fully support PM pregnancies. As an example, I was told that Dr. Zech had been asked not to advertise the offer of his clinic in Switzerland. I think that the prevailing regime of cautiousness prevents such views of being expressed publicly, even though they probably exist at a private level. Further research on the different positionings of clinicians and medical practitioners is needed in order to deepen and contrast the analysis.

considered as responsible for their condition, which is dependent on their age. It reinforces and naturalizes the norm of young fertile bodies and resists the decoupling of age and fertility

The second positioning takes into account the social transformations leading to delay in motherhood and the specific conditions – material necessity, finding the right partner, requirement related to work, lack of social support for women and families – that weigh on women when they want to start a family. In this positioning, the social and the biological cannot be disentangled. In contrast with the economy of responsibility identified in the first positioning, there is no moral judgment about the postponement of motherhood. Instead, there is a focus on women's sufferings and stress entailed by childlessness and the desire to have a child while they are not in the right place for it. The role of reproductive medicine is therefore to adjust to society's transformation, not to encourage the decoupling of age and fertility, but to alleviate these sufferings, as ARTs might bring hope and help to women to have children independently of the causes that lead to infertility. Instead of naturalising the biology of reproductive aging, what is naturalised here is the will to alleviate the sufferings entailed by childlessness by developing socio-technological arrangements in response to them, and thus the painful unfulfilled desire for a child.

Finally, the third positioning asserts a definition of age-related infertility as a social problem, which results in late pregnancies. Insistence is placed on the need to avoid late pregnancies for medical and ethical reasons. Therefore the role of ARTs as anti-aging, and the possible decoupling of age and fertility are both strongly resisted. Indeed, it is the illusory promise of ARTs as a technological fix to social problems that is denounced. The goal is rather to change society, not through medical means, but by social means, thus transforming the practitioner into a kind of social activist. This leads to the reinforcement of the naturalization of an intergenerational order and the need for continuity in family forms, as well as of the association between youth and fertility.

More generally, the analysis of these positionings has shown how the anti-aging dimension of ARTs challenges the role of reproductive medicine and becomes a matter of concern that forces the practitioners to negotiate and rearticulate the boundaries of the natural, the social, and the medical. While the distinction between these domains is reaffirmed by some practitioners, their inseparability is also recognized by others, in a shift from the normal/pathology distinction to a focus on the material conditions and sufferings of childless women. What is clear from the different positionings is that the social must in one way or another be taken into account, and

this, even more than the biology of reproductive aging, might no longer be sufficient to provide a grounding to the age limit of motherhood.

11. Conclusion

Frontier. What closes, limits, determines, separates. But also what can be pushed, conquered, reached, surpassed. Epistemological and discursive, frontiers are also deeply material and affect people's lives, their bodies, and their subjectivities. As a consequence, they are also deeply political. More than a space of hybridity (Franklin 2013a), where two separated domains might meet and mix, my journey on the frontiers of age has shown how they generate multiple material-discursive realities. At the same time made and making, determined and determining, limiting and unlimited, closing and opening, they have proved to be a relevant site in which to explore naturescultures entanglements and to see how associated dichotomies between passive/active, universal/local, real/unreal are blurred, or on the contrary ambivalently reproduced. Following the multiple directions and blossoming ramifications of the rhizome of age-related infertility, I have sometimes lost my way, but the materiality of the frontiers of age that I was bumping into all the time, helped me to stay the course.

By following the tracks of age-related infertility, this dissertation constitutes an original contribution to the social studies of reproduction. Especially by combining social studies on anti-aging technologies and medicine with literature on ARTs, I have been able to highlight several crucial aspects of the traffic between reproductive and anti-aging or regenerative sociotechnical projects. Instead of focusing on the transformations of the life course and of the timing of childbirth, I have brought my attention to the infrastructural elements enabling such transformations. In this way, my work represents a crucial contribution to the understanding of what age is, in relation to fertility and ARTs. As an anthropologist, I have chosen to highlight the multiplicity and the complexity of these relations, which forces us to slow the pace when discussing age-related infertility and ARTs, and to not take this category for granted by recalling how its reality is enacted in specific practices, but also acts back in surprising ways.

The first part of the dissertation showed how the biological frontiers of age are made, multiply along different scales – population, individual bodies, organs, cells, molecules – and generate conflicting realities of reproductive aging as both a fixed and inescapable frontier and as a moving one, only reached to be pushed further and transformed. This part focused especially on the traffic between the science of reproduction and the science of aging leading to these old and new frontiers of age. It documented the transformation of age as a statistical variable in relation to the demographic concept of infertility, haunted by the question of the biology, into aging as the biological processes affecting cells and organs. The analysis showed how the targeting of

reproductive aging and its localisation in a body part – cellular, or molecular – through the tool of transfer works as a condition of possibility for ARTs to work as anti-aging. Shedding light on the proximity of clinical and scientific logics enabled the exploration of the ways in which ARTs – sperm donation programs, IVF, egg donation, ooplasmic transfers – contribute substantially to the production of knowledge on reproductive aging. As a consequence of the traffic between the science of reproduction and of aging, reproductive aging becomes a matter of "only" aging. This has crucial effects for its ontology. As aging processes may be slowed down, or their effects reversed by rejuvenating older oocytes, the ontological status of reproductive aging and its theoretical models become objects of controversy. In this controversy, the putative existence of germline stem cells depends on the promissory work performed by reproductive biologists, as much as on their technical and epistemological work.

In addition, the first part shed light on the difficulties in isolating the effects of age alone on fertility, and the ongoing tension between the localisation of age inside the body or in environmental factors, which tends to blur the distinction between the inside and the outside of the body. While, the localisation of age as the site to target is a condition of possibility for ARTs to work as anti-aging and make older women's bodies reproductive, it also has the potential to transform the economy of responsibility associated with age-related infertility. Indeed, the ineluctability of aging processes happening inside the body and independently of one's own will does not entail the same circulation of agency as locating it in external elements, which can be consumed and depends upon life-style choices.

The second part explored how the frontiers of age are embodied, experienced, and materialize in clinical encounters and the trajectories of women turning to ARTs to have a child. It questioned how these frontiers result from the traffic between reproductive and anti-aging sociotechnical projects. On the one hand, I showed how age gets real through ARTs treatments and several apparatuses aiming at measuring the ovarian reserve and objectifying the effect of age on fertility. In addition, age emerges also as a resisting force through the repetition of failed treatment cycles and becomes a matter of time through the very specific temporality of ARTs treatments. On the other hand, I explored the potential of egg donation, when it works as an anti-aging procedure, to de-essentialise the relation between chronological and biological age, and showed how the frontiers of age might be transformed when fertility is medically extended.

The third part documented how the frontiers of age take the form of ethical and natural limits in the debates about the future of reproduction and the possibility of assisting medically the

extension of fertility through egg donation and egg freezing. I studied how the possible anti-aging role of reproductive medicine is actively discussed and resisted in the Swiss context. In these debates, the nature of the age limits of fertility becomes the object of an ethical boundary-work where the frontiers between what is normal and what is pathological, as well as what justifies the intervention of ARTs, are sites of intense negotiations. The analysis permitted the characterization of the regime of cautiousness prevailing in the regulation of the medically-assisted extension of fertility and the specific temporal tension at its core, as it is inhabited by the past but also turned towards the future in the careful discussions about what the future of reproduction is, might, could, or should be.

What the last part highlighted, in addition, is how the question of nature is deeply political. A reproach addressed to ontological or materialist approaches is that they tend to make the broader picture invisible in the sense of structural inequalities of class, gender, and race. The critique is that by focusing on the ontological status of entities and categories, on their materialities, and on situated practices, we lose sight of their political dimension and of the power relations in which they are embedded. By paying attention to the agency of non-human entities, one might dismiss human subjects' agency, or lack of it.

A concern for the politics of ontology or reality was expressed by Anne-Marie Mol in 1999. "Ontological politics", she writes, "have to do with the way in which "the real" is implicated in the "political", and vice versa" (Mol 1999: 74). Discussing the political effects of multiplicity enacted in practices, she focuses critically on the idea that one could choose between these different versions. She stresses especially the "reality effects" of these versions and questions the conditions – where, what, how, who – of the possible choices entailed by multiplicity. While she does not deal with the more global inequalities engendered by the multiple versions of the diagnostic category under study here, she addresses the difficulties of articulating politics in her article, thought of in terms of deliberation or choice, and multiple ontologies.

In order to think further about the politics of ontology, and the ontology of politics, the concept of "potentiality" developed by Taussig, Hoeyer and Helmreich (2013) has been most useful for me. This concept engages with life sciences and biomedicine. It grasps the shifting relations between nature and culture, and indexes a "gap between what is and what might, could, or even should be", a gap which both "produces and depends on a view of life as plastic, susceptible to forming and reforming" (Taussig, Hoeyer and Helmreich 2013: S5). Potentiality is therefore a

crucial concept for addressing the transformations of the naturescultures of reproductive aging and the emergence of new frontiers of age.

However, as the authors recall, etymologically potentiality has roots in the concept of power, and "framing something in terms of potential is a political act" (Taussig, Hoeyer and Helmreich 2013: S6). Therefore, attributing potentiality is not a neutral act. It has effects in terms of inclusion and exclusion, on inequalities and the sharing out of resources, on "possibilities it facilitates", and on "options it forecloses" (Taussig, Hoeyer and Helmreich 2013: S12). Speaking of potentiality entails therefore that one asks what kinds of futures are opened, for whom, and under which conditions, and that one questions the moral economies at stake in the material-discursive ascriptions of potentiality. This is what the third part of this dissertation has contributed towards. While I have not articulated class, gender, race, and age inequalities and hierarchies at a global level, as research on "stratified reproduction" (Colen 1995) would invite us to do, I have chosen to focus on how the various ontological statuses attributed to the frontiers of age have political effects.

In other words, I have shown how the naturalization of the age-related fertility decline is used on the one hand to exclude older women from access to ARTs, which would enable them to have a child later in life, while on the other, it serves the inclusion of younger women by helping them to reestablish the normality of the life course and of young fertile bodies. I have shown how the will to prevent the use of ARTs to extend fertility as an easy technological fix, by changing society and the lack of infrastructural support for women with children, paradoxically reinforces a naturalized view of the life course and of the incompatibility of aging and fertility in women. Finally, I have shown how various economies of responsibility are at stake, where women are in turn the victims of society, of men whose reproductive calendars are not synchronized with theirs, of their own biologies, genetically fixed for centuries, and held responsible for postponing childbirth for selfish reasons. According to these different enactments of women, the naturescultures of the age-related fertility decline are shifting, showing how thinking of age limits in terms of a fixed nature, or in terms of a biological frontier that can be transformed technologically, is deeply political.

To conclude, I would like to highlight two directions for further research. The politics of the frontiers of age could be deepened and extended. My dissertation confirms that starting from "potentiality" opens up an interesting way of articulating ontology and politics. Focusing more systematically on the political dimension of ontology, and the ontological dimension of politics,

either in other national contexts in a comparative way, or still in the study of reproductive aging, but by deepening the theoretical and empirical study of its ontopolitics, would certainly contribute to an enrichment of the literature on ontology, new materialism, potentiality, and ARTs.

Another direction for research opened up by my work concerns the traffic between the science of reproduction and the science of aging, resulting in the category of reproductive aging and its moving frontiers. While some aspects of this traffic have been explored in this dissertation, many others remain in the shadows. As increasingly new technological and medical means of evaluating, anticipating, preventing, targeting, circumventing, and intervening on reproductive aging, may develop in answer to the biopolitical concern of the postponement of childbirth, this traffic intensifies and its multiple ramifications are all far from having been explored in this dissertation. This would greatly contribute to the study of anti-aging and reproductive technologies.

Frontiers of age. Old and new. Fixed and immutable. Changing and constantly pushed away. So real and material. So political and social. Belonging to the future and so intensely present at the same time. Now that I have explored many of their facets and highlighted their multiplicity and complexity, I hope that my work will contribute to nourishing further discussions on age, ART's and infertility, and that the questions that I have asked and tried to answer, will generate new questions and answers, in which the understanding of these frontiers will be further improved and problematized. Like a new frontier, I hope that my work opens up more than it closes down, and that as a partial account in its incompleteness and situatedness, its unanswered questions will stimulate the imagination of new paths to follow and new directions to explore.

Appendix 1

Glossary of Medical Terms

AMH: Anti-Müllerian Hormone, also known as Mullerian Inhibiting Substance. AMH is produced by granulosa cells of the pre-antral and small antral follicles and its levels can be assessed in serum. When follicle number decreases, AMH level does too. It thus provides information on their number, and this independently from the day of the menstrual cycle. It plays an important role in follicle development and selection, and is not detectable any more after the menopause. AMH is used as a marker of the ovarian reserve and as a predictor of the number of oocytes retrieved in IVF cycles. It is to be noted that AMH plays also a role in male sexual differentiation. Exact measures and threshold values can vary depending on the laboratory and clinical practices. According to Vulliemoz et al. (2006), AMH under 3 pmol/l means that there is no chance of pregnancy, between 3 and 5 pmol/l means a poor ovarian reserve, between 5 and 10 pmol/l means that something might be wrong, and between 10 and 42 pmol/l is considered normal.

References: Broekmans et al. (2008); La Marca et al. (2009); Lehmann et al. (2014); Rooij et al. (2002); Szafarowska, Molinska-Glura and Jerzak (2014); Tremellen et al. (2005); Visser et al. (2006); Vulliemoz et al. (2006).

Antral Follicle Count (AFC): It is a transvaginal ultrasound examination usually performed on day 3 of the cycle (or between day 2 and day 4). It aims at counting the number of antral follicles (between 2 and 10mm) in order to predict the response to the hormonal stimulation and evaluate the state of the ovarian reserve (the number of primordial, microscopic, follicles containing an immature egg that can potentially develop and ovulate). Difficulties with AFC are related to biological variation and inter-observers differences. Values may vary depending on the clinic and the medical practice. According to Vulliemoz et al. (2006) a count over 7 is normal, between 5 and 7 is dubious, and under 5 is bad. AFC might be a more reliable biomarker of success rates with IVF than FSH levels.

References: Bancsi et al. (2002b); Vulliemoz et al. (2006); Reuss et al. (1996); Sills, Alper and Walsh (2009); Grande et al. (2014); Chang et al. (1998); Klinkert et al. (2005); Scheffer et al. (1999).

Aneuploidy: Designates an abnormal number of chromosomes in a cell (the normal number is 46). It is a leading cause of embryo defects, miscarriages, and birth of children with health problems, such as Down syndrome. Oocytes, which contain only 23 chromosomes, are arrested

in a fragile state of cellular division at birth and aneuploidy results from errors in the recombination of chromosomes when they complete meiosis during ovulation and after fertilization. Maternal age has been shown to be a major risk factor of increased rates of aneuploidy that might be due to dysfunctions in the meiotic segregation and recombination mechanisms and to the loss of the ability of the cell to repair these errors.

References: Battaglia et al. (1996); Brook, Gosden and Chandley (1984); Chiang, Schultz and Lampson (2012); Jones and Lane (2012); Kornafel and Sauer (1994).

Antioxydative: Designates molecules able to prevent the chemical reactions of oxydation. While oxydation is necessary to life, oxidative stress has also been shown to play an important role in the pathogenesis of many diseases, and especially of aging. The theory of the free radical was proposed by Harman in the 1950s. It explains aging processes as the "deleterious side attacks of free radicals" produced during the oxydation and how antioxydatives are precisely able to slow down and stop. Antioxydatives can be internal or external, for example vitamin C. The role that "reactive oxygen species" (ROS), a byproduct of the chemical reaction of oxydation, play in reproductive aging processes, as well as the search for other metabolite playing a similar role, has become an object of study in reproductive biology.

References: Bentov and Casper (2013); Harman (1981); Harman (1992); Harman and others (1955); Meldrum (2013); Practice Committee of American Society for Reproductive Medicine in collaboration with Society for Reproductive and Infertility (2008); Tatone and Amicarelli (2013).

Apoptosis: Designates the tightly controlled process of programmed cell death. It is the complementary process to cell division and multiplication. In contrast to necrosis, apoptosis is not pathological and is necessary to the life of the organism. In 1885, Walther Flemming was the first to give a precise morphological description of this process, but the term "apoptosis" was coined in the 1970s by Kerr and colleagues in the framework of cancer research. Research on the biochemical components playing a role in apoptosis and regulating it developed particularly in the 1990s. Apoptosis plays a key role in ovarian physiology in the development of foetal ovaries and in the postnatal ovarian cycle. Therefore understanding the apoptosis processes in oogenesis and the regulation of ovarian reserve could open up the possibility of regulating the size of the follicles pool.

References: Clarke and Clarke (1996); De Felici (1997); Flemming (1885); Kerr, Wyllie and Currie (1972); Pru and Tilly (2001); Tilly (1996); Tilly (2003a); Tilly (2001); Vaskivuo and Tapanainen (2003).

Atresia (follicular): Etymologically from Greek: a = not and tresia = perforated. Refers literally to the failure of a follicle to rupture or ovulate. It is the hormonally controlled apoptotic process of follicle cell death. The great majority of follicles undergo atresia. The adjective atretic is used to designate the degenerating follicles (the ones which will not be ovulated).

References: Hsueh, Billig and Tsafriri (1994); Kaipia and Hsueh (1997); Townson and Combelles (2012); Yu et al. (2004).

Autologous: Derived or transferred from the same individual's body. In the context of medical donation or transfer, it means that the donor and the recipient are the same person.

Reference: http://www.merriam-webster.com/dictionary/autologous - accessed on January 4, 2015.

Azoospermia: Refers to the absence of sperm in at least two separate ejaculate samples. It affects 1% of men in the general population, and 10-15% of all infertile men, and entails very low levels of fertility, or even sterility.

Reference: Gudeloglu and Parekattil (2013).

Beta-hCG: Hormone called human chorionic gonadotropin. Starts to be produced when the embryo implants in the placenta after descending the fallopian tubes, that is, about 10 days after conception. It is secreted by the placenta and helps to maintain the pregnancy by stimulating the production of progesterone. Its peak is reached at the end of the first trimester of the pregnancy. After this time, its level decreases slowly until birth occurs. It can be detected in the blood or in the urine. If its level decreases during the first trimester, it might be the sign of a potential miscarriage.

References: Campbell (1995); Manuila et al. (1999a); http://www.webmd.com/baby/human-chorionic-gonadotropin-hcg - accessed on December 28, 2015; http://www.merriam-webster.com/dictionary/human%20chorionic%20gonadotropin - accessed on December 28, 2015.

Biomarker: Abbreviation of biological marker. The term was defined in 1998 by the National Institute of Health Biomarkers Definition Working Group, as "a characteristic that is objectively measured and evaluated as an indicator of normal biological processes, pathogenic processes, or pharmacologic responses to a therapeutic intervention". In other words it is a measurable indicator observed from the outside for a health condition or a specific biological state, independently from specific symptoms.

Reference: Strimbu and Tavel (2010).

Blastocyst: Stage of embryo development reached on the fifth day after conception. In medically-assisted conception, its culture and transfer are associated with higher implantation rates, and provide the possibility of selecting the most viable or the best quality embryo. Therefore, it allows for fewer embryos to be transferred and for aiming at single embryo transfer (SET).

References: Hardarson, Van Landuyt and Jones (2012); The Practice Committees of the American Society for Reproductive Medicine and the Society for Assisted Reproductive (2013); http://www.embryology.ch/anglais/evorimplantation/furchung02.html - accessed on December 28, 2015; http://www.hfea.gov.uk/blastocyst-transfer.html - accessed on December 28, 2015.

Chromosome: Containing genetic information, chromosomes are found in the cell's nucleus. They comprise DNA molecules and proteins, characterizing each individual. Somatic cells carry 46 chromosomes, or 22 pairs of chromosomes and 1 pair of sexual chromosome (X and Y). Sex cells, the oocyte and the sperm, carry only 23 chromosomes. When they unite, the resulting embryo inherits half of its chromosomes from its father, and half from its mother.

Reference: Campbell (1995).

Cryptorchidism: Designates the congenital absence or non-descent of one or both testes in the scrotum. It is the most common genital disorder identified at birth. Associated with reduced fertility.

Reference: Kolon et al. (2014).

Cryopreservation: Refers to the preservation of cells and tissues by freezing. The goal is to reach low or very low temperatures without damaging them. It relies on cryoprotectants able to protect the cells/tissues from cold, but these may have cytotoxic effects. Cryopreservation is crucial in reproductive medicine as it is used to preserve sperm, embryos, and more recently oocytes.

References: Pegg (2007); http://www.medicinenet.com/script/main/art.asp?articlekey=7252 - accessed on December 26, 2015.

Cytoplasm: Designates the fluid contained in the cells outside the nucleus. It is made mainly of water, but contains also enzymes, salts, various organic molecules, and organelles, among which

are the mitochondria, necessary to the energy metabolism of the cell and playing a role in aging processes.

Reference: http://biology.about.com/od/biologydictionary/g/cytoplasm.htm - accessed on December 27, 2015.

Cytotoxic: Designates any agent or process likely to damage or kill cells.

Reference: http://www.medicinenet.com/script/main/art.asp?articlekey=19883 - accessed on December 27, 2015.

Dictyotene ova: Designates a phase of oogenesis, which is the process of formation and development of oocytes. What characterizes the development of gametes – oocytes and sperm – is meiosis, a process of cellular division resulting in the reduction of the initial number of chromosomes by half. Meiosis is divided into a prenatal and postnatal phase, each of which includes several stages. The dictyotene stage is the resting phase of the oocytes, enclosed in primordial follicles, in the ovary, that is between the prenatal and the postnatal completion of meiosis. From puberty, each month, some oocytes are recruited to mature by resuming this first part of the meiosis process, but only one will ovulate, while the other oocytes undergo atresia (programmed cell death: see above) The whole process of meiosis is only completed when fertilization with sperm occurs. Some oocytes will stay at the dictyotene stage (primordial follicles) up to the menopause.

References: Mastroianni and Paulsen (1986); http://www.embryology.ch/anglais/cgametogen/oogenese01.html - accessed on December 27, 2015; discovery.lifemapsc.com/library/review-of-medical-embryology/chapter-4-gametogenesis-oogenesis - accessed on December 27, 2015.

Dysgenesis: Etymologically means a defective development. Used to designate an abnormal organ development during embryonic growth and development, that may be genetically inherited or due to chromosomal abnormalities. When it concerns the ovaries or testes, one speaks of gonadal dysgenesis.

References: http://medical-dictionary.thefreedictionary.com/dysgenesis - accessed on December, 27, 2015.

Egg donation: Also oocyte or ovum donation. It is an IVF (*in vitro* fertilization) procedure where the recipient and the donor are not the same person. The recipient carries the embryo conceived with the egg of a donor, which means that it is not genetically related. The procedure entails complicated synchronization between the hormonal preparation of the uterus of the recipient and the hormonal stimulation of the ovaries of the donor. The use of vitrification

allowing the freezing of oocytes might simplify the procedure by removing the need for synchronization. It is still one of the main means enabling older women, pre-, peri-, or post-menopausal to become pregnant and have a child in spite of ovarian aging.

References: Sauer (1998); Sauer and Kavic (2006); Scott and Rosenwaks (1990).

Endometrium: It is the inner mucosa of the uterine cavity where implantation takes place. It undergoes morphological and functional changes under the influence of the hormones regulating ovulation. Its thickness changes in association with the menstrual cycle, as it thickens and is richly irrigated with blood in order to prepare for the implantation of the fertilized oocyte. When there is no implantation, the superficial layer of the endometrium is shed and expelled, leading to menstruation. Its thickness can be measured by ultra-sound and it plays an important role in success rates in IVF. The role of the endometrium in reproductive aging is still discussed.

References: Erel et al. (2005); Richter et al. (2007); Ubaldi et al. (2003); http://www.embryology.ch/anglais/gnidation/role01.html - accessed on December 27, 2015; http://www.embryology.ch/anglais/gnidation/role02.html - accessed on December 27, 2015.

Follicle (ovarian): Designates the round cellular structure containing the oocyte. The size varies as some follicles are recruited to mature. Primordial follicles are the thin layer of cell surrounding primordial oocytes after birth (dictyotene stage). After puberty, in association with the menstrual cycle and under the influence of sex hormones (especially FSH), some of them develop into primary, secondary (called preantral follicles), and tertiary follicles which are filled with fluid (antral follicles), possibly ending up in a graafian follicle (mature) which is ready to ovulate. About a year is needed to transform a primordial follicle into a mature oocyte ready to ovulate and be fertilized. The process of development and maturation of follicles is called folliculogenesis. As only one follicle results in ovulation, folliculogenesis is considered a highly selective process. The follicles secrete some hormones which play a role in the menstrual cycle. More precisely, secondary and tertiary follicles secrete oestrogens, which stimulate the growth of the uterine mucous membrane.

References: Erickson (2004); Faddy (2000); Gougeon (1986); Gougeon (1998); Macklon and Fauser (1998); http://www.embryology.ch/anglais/cgametogen/oogenese02.html - accessed on December 27, 2015; http://www.gfmer.ch/Books/Reproductive_health/Folliculogenesis_and_ovulation.html - accessed on December 27, 2015.

Free radical theory: see antioxydative.

References: Harman (1981); Harman (1992); Harman and others (1955).

FSH: Follicle-stimulating hormone. Hormone secreted by the anterior pituitary gland which is located in the underside of the brain. It stimulates the maturation of ovarian follicles in the ovaries and fosters the liberation of oestrogens in the ovaries. It circulates in the blood and its levels vary according to the menstrual cycle. Its peak is reached just before ovulation. In assisted reproductive medicine, it is usually measured on Day 3 of the cycle in order to evaluate the ovarian reserve in combination with the antral follicle count and other hormones' measurement. The more the ovarian reserve is depleted, the more FSH level increases. According to Vulliemoz et al. (2006) when it is over 12 mUI/ml it means that the ovarian reserve is failing; when it is between 8 and 12 mUI/ml it indicates that the state of the ovarian reserve is uncertain; and when it is below 8mUI/ml it is normal. The level of FSH increases about a decade or more before menopause. It is also injected in hormonal stimulation in preparation for IVF in order to produce many eggs instead of the one usually released during ovulation.

References: Galtier Dereure, Bringer and Hedon (1996); Schally, Kastin and Arimura (1971); Toner et al. (1991b); Ubaldi et al. (2003); Vulliemoz et al. (2006); Watt et al. (2000).

Gametes: Also called germ cells or sex cells. In women, it is the oocyte, and in men, it is the sperm. Contain only 23 chromosomes, in order to allow a redistribution of the genetic material when fertilization occurs. The process of cellular division of gametes is called meiosis. Gametogenesis describes the process of formation and development of gametes, namely spermatogenesis and oogenesis.

References: http://discovery.lifemapsc.com/library/review-of-medical-embryology/chapter-3-gamete-germ-cell-formation-or-gametogenesis-spermatogenesis - accessed on December 28, 2015, http://discovery.lifemapsc.com/library/review-of-medical-embryology/chapter-4-gametogenesis-oogenesis - accessed on December 28, 2015.

Germline: The cell line from which egg or sperm cells originate and are derived. May also designate the genetic content of germ cells, that is passed on to offspring.

References: http://ghr.nlm.nih.gov/glossary=germline - accessed on December 28, 2015; http://www.merriam-webster.com/dictionary/germ%20line - accessed on December 28, 2015; http://www.medicinenet.com/script/main/art.asp?articlekey=13539 - accessed on December 28, 2015.

Germ cells: Oocytes and sperm are called germ cells, in contrast with the other cells of the body, called somatic cells.

Reference: http://ghr.nlm.nih.gov/glossary=germline - accessed on December 28, 2015.

Granulosa Cells: The somatic cells surrounding the maturing oocytes in follicles. They play an important role in the production of oestrogens (in the follicular phase of the menstrual cycle) and progesterone (after the ovulation) and the fine tuning of hormones in the reproductive system.

Reference: http://www.embryology.ch/anglais/dbefruchtung/eisprung02.html - accessed on December 28, 2015.

Heterologous: From a different species.

Reference: http://www.merriam-webster.com/dictionary/heterologous - accessed on December 28, 2015.

Histology: The study of the microscopic details and structures of biological cells and tissues, using light fluorescence or electron microscope, examining a thin slice (called a "section") of tissues that have been previously prepared using appropriate processes called "histological techniques" (Musumeci 2014). It was an eminent academic discipline in the 19th century that developed especially in the beginning of the 20th century due to the improvement of staining techniques.

Reference: Musumeci (2014).

Hydrosalpinx: From the Greek: hydro = water, and salpinx = a tube-shaped structure with a flared opening. Designates the condition of the fallopian tubes when they are blocked, distended and filled with a clear, serous fluid. It causes infertility by preventing the embryo from descending the tube to implant. The fluid can also go into the uterus and prevent implantation. It is often the result of a previous infection, that might be sexually transmitted.

References: http://medical-dictionary.thefreedictionary.com/hydrosalpinx - accessed on December 28, 2015; http://bioetymology.blogspot.ch/2011/11/salpinx.html - accessed on December 28, 2015; https://www.asrm.org/FACTSHEET_Hydrosalpinx/ - accessed on December 28, 2015.

Hyperstimulation: (ovarian hyperstimulation syndrome, OHSS). It is one of the most serious complications related to hormonal stimulation (ovulation induction therapy) in preparation for IVF and that occurs when the ovarian response is unexpectedly exaggerated. The syndrome can

be mild, moderate, or severe. The treatment cycle may be cancelled, but the complication might be life-threatening (renal failure, adult respiratory distress) and requires hospitalization.

References: The Practice Committee of the American Society for Reproductive Medicine (2008); http://www.cpma.ch/fr/patients/risks/syndrome-of-ovarian-hyperstimulation.html - accessed on December 28, 2015.

ICSI: Intra-cytoplasmic sperm injection. Designates the procedure by which a single live sperm is injected into the cytoplasm of the oocyte, in contrast with traditional IVF where fertilization occurs in a petri dish without selecting a sperm. It is performed under a microscope using micromanipulating devices, introduced in the late 1980s. The technique was developed by a Belgian team and the first baby conceived through IVF-ICSI was born in 1992. The initial indications for it were severe male infertility, for which it has proven very efficient, to the extent that egg quality and egg number are now major determinants in overcoming male infertility. The range of indications has broadly extended including for example unexplained infertility or poor quality oocyte, and ICSI tends to be used routinely, but its benefits have not been proven.

References: Sherins et al. (1995); The Practice Committees of the American Society for Reproductive Medicine and the Society for Assisted Reproductive (2012); Zhao et al. 2011 ; https://www.asrm.org/FACTSHEET_What_is_intracytoplasmic_sperm_injection_ICSI/ - accessed on December 28, 2015.

IMSI: Intracytoplasmic Morphologically Selected Sperm Injection. Technique used in combination with ICSI (micromanipulation of gametes). Allows an improved selection of sperm thanks to high magnification (over 6000x).

Reference: Teixeira et al. (2013).

In vitro: Etymologically from Latin, means in the glass. Refers to processes out of the body, out of living organisms, for example in cultured cells.

Reference: http://www.merriam-webster.com/dictionary/in%20vitro - accessed on December 29, 2015.

In vitro fertilization (IVF): Refers to fertilization occurring in a petri dish, out of the body, in the lab. Includes the retrieval of male and female gametes, their handling, and fertilization in a media culture, under controlled conditions. When fertilized and developing well, the oocytes are transferred into the uterus of the woman for implantation, leading possibly to a pregnancy. The first baby born by IVF was Louise Brown in the UK in 1978, as the result of the joint efforts of

the reproductive biologist, Robert Edwards, and, the gynaecologist and pioneer of laparoscopy, Patrick Steptoe. In 2010, Robert Edwards was awarded the Nobel Prize for Physiology and Medicine for the development of IVF.

References: Cohen et al. (2005); Johnson (2011); Zhao et al. (2011).

In vivo: Opposite of in vitro. Refers to processes observed in living organisms and not in culture, in a petri dish.

Reference: http://www.medicinenet.com/script/main/art.asp?articlekey=4034 - accessed on December 29, 2015.

Metaphase II: Designates the second phase of the second part of meiosis (meiosis II), which is the specific process of cell division occurring in germ cells. In meiosis II the reduction of chromosomes by half (46 to 23) has already occurred. Meiosis II begins with two haploid cells (23 chromosomes) and ends with four haploid cells, carrying singular genetic material. This phase is similar to what happens in mitosis, the division of somatic cells. Metaphase II designates the specific moment of division when chromosomes align in preparation for the new division. During each menstrual cycle, gonadotropins induce meiotic maturation of growing oocytes into fertilizable eggs. Metaphase II designates the state of arrest of the oocyte before fertilization.

References: Clift and Schuh (2013); Kubiak et al. (1993)*;* http://www.macroevolution.net/metaphase-ii.html - accessed on January 4, 2016; http://cyberbridge.mcb.harvard.edu/mitosis_7.html - accessed on January 4, 2016.

Meiosis: From the Greek, means diminution. Designates the process of cellular division proper to germ cells. It includes two main stages: meiosis I and meiosis II. The first division comprises the reduction by half of the number of chromosomes in the nucleus. During this phase of meiosis, chromosomes are shuffled or recombined (recombination is a process that breaks, recombines and rejoins sections of DNA to produce new combinations of genes) leading to the creation of a gamete with a unique genetic material. The second phase consists of the division of the cell body by half. The result of meiosis is four haploid cells (contain only 23 chromosomes in the human species, in contrast with diploid somatic cells which contain 46 chromosomes). Four steps can be distinguished: prophase, metaphase, anaphase, and telophase.

References: Campbell (1995); Manuila et al. (1999b); http://www.nature.com/scitable/definition/meiosis-88 - accessed on December 28, 2015; http://www.ncbi.nlm.nih.gov/books/NBK26840/ - accessed on December 28, 2015.

Mitochondria: Round or oval organelles found in the cytoplasm of eukaryotic cells (with well-defined nuclei) and surrounded by a double membrane. They have their own genome, which means that they contain a small and specific amount of DNA which is distinct from nuclear DNA. This genetic material is inherited maternally, because the oocyte transmits its ooplasm to the embryo, while the sperm mitochondria are usually destroyed. They have their own process of division-multiplication, distinct from cell division. They play an important role in the metabolism of the cell by contributing to the production of energy, as well as in cell growth and death. Their number per cell can vary and is correlated with the cell's need for energy. Accumulation of mutations and alteration in mitochondrial structure and function, related to age, contribute to a reduction of oocyte quality. Consequently, the loss of mitochondrial activity in oocytes from older women may contribute to lower embryo development and a decrease in pregnancy rates, as observed in IVF. The role of mitochondria in reproductive aging is increasingly studied.

References: Barritt et al. (2001); Bentov and Casper (2013); Koene and Smeitink (2011); Kujjo and Perez (2012); Meldrum (2013); Wilding et al. (2001); http://www.nature.com/scitable/topicpage/mitochondria-14053590 - accessed on January 4, 2016; http://www.britannica.com/science/mitochondrion - accessed on January 4, 2016.

Mitosis: Designates the cellular division process of somatic cells. It is characterized by the cell replication into another identical cell, containing the same number of chromosomes. Four steps can be distinguished: prophase, metaphase, anaphase, and telophase.

References: Manuila et al. (1999c).

Molecular: Biological organization rests on a hierarchy of structural levels. Atoms are the smallest chemical components of body matter. When they are linked together they form molecules. These molecules can vary greatly in size and complexity. Proteins, vitamins, water (H2O), DNA or RNA are molecules. Molecular biology is the part of biological research which searches for explanations at the molecular level by a description of their structures, interactions, functions, and makeup. It has developed especially since the second half of the twentieth century. There are some debates as to whether it is a scientific discipline or a paradigm, a "molecular vision" of organisms. Epigenetics and synthetic biology represent its newest developments.

References: Campbell (1995); Morange (2001); http://www.medicinenet.com/script/main/art.asp?articlekey=25720 - accessed on December 29, 2015; http://whatis.techtarget.com/definition/molecule - accessed on December 29, 2015.

Morphology: In biology, the study of the size, structure and shape (the Greek, morpho) of living things or organisms. Does not study their function (which is the object of physiology).

References: http://www.biology-online.org/dictionary/Morphology - accessed on December 29, 2015; https://www.britannica.com/science/morphology-biology - accessed on December 29, 2015.

Oogenesis: Designates the processes by which the female gametes, the oocytes, are produced. Oogenesis is a highly complex process regulated by a vast numbers of intra- and extra-ovarian factors, many aspects of which are still unknown and debated. According to the dominant theory, the human embryo oogonia, which originate from primordial germ cells, divide significantly between the second and the seventh month (reaching 7 millions of germ cells). During the two last months of pregnancy, this number drops precipitously (to reach between one and two millions at birth). The remaining oogonia enter the first stage of meiosis and are called primary oocytes. After birth, they enter a state of arrest (dictyate stage of meiosis I), lasting until puberty. After puberty, under the influence of sex hormones, a group of oocytes is recruited periodically and resume meiosis. They transform into primary, secondary , preantral and antral follicles. The notion that women are born with all the oocytes they will ever have was challenged in the 2000s and is still a matter of dispute.

References: Bukovsky et al. (2005); Greenfeld and Flaws (2004); Sánchez and Smitz (2012); Tilly, Niikura and Rueda (2009); http://www.ncbi.nlm.nih.gov/books/NBK10008/ - accessed on January 4, 2016; http://discovery.lifemapsc.com/library/review-of-medical-embryology/chapter-4-gametogenesis-oogenesis - accessed on January 4, 2016; http://www.britannica.com/science/oogenesis - accessed on January 4, 2016.

Ooplasm: Designates the cytoplasm of the oocyte. The cytoplasm is the liquid part of the cell. Contains cellular organelles such as mitochondria and water content. Most metabolic processes take place in the cytoplasm.

References: Schäffler and Schmidt (1998).

Ovarian reserve: Designates the state of the pool of oocytes remaining in the ovaries, which is correlated with the reproductive potential of a woman. According to the dominant theory in reproductive biology, women are born with all the egg-containing follicles that they will ever have. At birth, they have one million follicles dropping to 300,000 at puberty, from which 300 will be ovulated during reproductive years, the others undergoing atresia, a process of controlled cell death. One speaks of a loss of the ovarian reserve, or of diminished or depleted ovarian reserve to designate the loss in quantity and quality affecting the oocytes. It is usually age-related

and a physiological process, but can also be due to a history of premature ovarian failure, smoking, and prior ovarian surgery. The ovarian reserve can be tested by several means, that are usually combined, and include the measurement of hormone blood levels (FSH, estradiol, AMH), the antral follicle count (AFC), or the response to gonadotropins, hormones used to stimulate ovulation (grow multiple eggs at once). No test has been proven to be 100% reliable for predicting pregnancy. The notion of the ovarian reserve rests on the "fixed pool model", challenged by the proponents of the "stem-cell model", who argue that there are renewal processes in ovaries occurring in adult life.

References: Tilly, Niikura and Rueda (2009); Woods and Tilly (2012); https://www.asrm.org/FACTSHEET_Ovarian_Reserve_in_Women_Prediction_of_Fertility_Potential/ - accessed on January 4, 2016; https://www.asrm.org/BOOKLET_Age_And_Fertility/ - accessed on January 4, 2016.

Ovary: Women's internal genital organ, situated in the small pelvis and usually one of a pair. Ovaries play a role in the production of the sexual hormones progesterone and oestrogens. They are also the site where ooegenesis, that is the production, development, and maturation of oocytes, takes place.

References: Schäffler and Schmidt (1998).

Ovum: Also called ova, oocyte or egg. As a generic term, designates the female reproductive cell or germ cell, able after fertilization to lead to the development of a new human being. More technically, designates the mature oocyte, ready for fertilization.

Reference: http://medical-dictionary.thefreedictionary.com/ovum - accessed on December 29, 2015.

Oxydative stress: Part of the free radicals theory of aging proposed by Harman in the 1950s. Designates an imbalance between antioxydative defences and oxidative stress byproducts, leading possibly to cellular damage. Its role in reproductive aging is still researched. See also anti-oxydative.

References: Betteridge (2000); Harman (1992); Harman and others (1955); Meldrum (2013); Tatone and Amicarelli (2013).

Pituitary Gland: Also called hypophysis. It is a pea-size endocrine gland situated at the base of the brain, under the hypothalamus, which controls it. The pituitary gland plays an important role in the regulation and production of hormones, including sexual hormones, such as FSH, LH (Luteinizing hormone), and prolactin, all important for reproduction.

References: http://www.endocrineweb.com/endocrinology/overview-pituitary-gland - accessed on December 29, 2015; http://www.merckmanuals.com/home/hormonal-and-metabolic-disorders/pituitary-gland-disorders/overview-of-the-pituitary-gland - accessed on December 29, 2015.

Preimplantation Genetic Diagnosis (PGD): Technique performed in the lab and using IVF. One or two cells of the embryo are removed and tested before implantation in order to see if they are affected by a specific genetic disorder. Healthy embryos, unaffected by the disorder, can be implanted in the uterus. PGD is for someone who has or is a carrier of a known genetic disorder.

Reference: https://www.asrm.org/FACTSHEET_Preimplantation_genetic_testing/ - accessed on January 2, 2016.

Stem cells: Cells found in embryos at a very early stage (called embryonic stem cells) and in some types of adult tissues. They are undifferentiated or pluripotent, meaning that they do not have a specialized function. They have important potential as they could be used to create various kinds of other cells in order to cure specific diseases or conditions.

Reference: https://www.asrm.org/FACTSHEET_Stem_Cell_Research/ - accessed on January 2, 2016.

Three-person IVF: Three-person IVF may be performed in the case of severe mitochondrial diseases of the future mother. Her egg's healthy spindle is injected into a previously enucleated egg of a donor which contains healthy mitochondria (Maternal Spindle Transfer (MST)) and then fertilized with the future father's sperm. Alternatively, a similar procedure can be performed on fertilized eggs which are still in the status of a single cell (Pronuclear Transfer (PNT). In both cases, the child that results from this fertilization technique is genetically related to three 'parents' and both procedures constitute irreversible modifications of the germline.

Reference: http://www.geneticsandsociety.org/article.php?id=6527 - accessed on December 30, 2015.

Ultrasound: Also called sonography. It is a real-time scanner using sound waves to develop images on a computer screen enabling the inside of the body to be viewed. A transducer emitting high-frequency sounds is put directly onto the skin. The ultra-sound scanner records the echoes as the sound waves bounce back and is able to transform them into images. It gives information on the size, shape, and consistency of soft tissues and organs. It is crucial to several procedures in reproductive medicine, such as the antral follicle count, the monitoring of the ovarian response, and the injection of the fertilized oocytes in the uterus.

References: Reuss et al. (1996); http://www.webmd.com/a-to-z-guides/what-is-an-ultrasound - accessed on December 29, 2015.

Vitrification: To vitrify is to transform a substance into "glass". The term is used to describe the "glass aspect" of vitrified cells. Vitrification consists of an ultra rapid cooling process where oocytes are placed in extremely low temperature (up to -1000C) of liquid nitrogen, where molecular activity ceases. High cryoprotectant doses are used to prevent the formation of ice crystals due to their viscosity. This technology has recently made possible the cryopreservation of oocytes with success rates similar to the use of fresh oocytes in IVF. It opens up the possibility of preserving oocytes for oneself, commonly referred to as "social egg freezing".

References: Blyth, Lee and Yee (2013); Cobo et al. (2013); Gook and Edgar (2007); The PracticeCommittees of the American Society for Reproductive Medicine and the Society for Assisted Reproductive Technology (2013); Waldby (2014).

Zona pellucida: Extracellular envelope formed surrounding the mammalian oocyte as it develops in the ovary. It is composed of three glycoproteins and plays an important role in fertilization, as sperm must be able to penetrate the zona pellucida to fertilize the egg, but also in the recognition process of sperm, as the zona pellucida prevents interspecies fertilization.

References: Wassarman et al. (1999); http://www.medicinenet.com/script/main/art.asp?articlekey=11822 - accessed on December 29, 2015; http://www.merriam-webster.com/dictionary/zona%20pellucida - accessed on December 29, 2015.

Zygote: Designates the fertilized oocyte before the merging of the two pronuclei, 22 hours after fertilization. It is the first cell of a new organism with an individual genome.

Reference: http://www.embryology.ch/anglais/dbefruchtung/zygote03.html - accessed on December 29, 2015.

Appendix 2

The Swiss Reproductive Medicine Act (RMA)

This appendix provides information on the Swiss Reproductive Medicine Act and on the current state of the regulation. The RMA (810.11) was adopted by popular vote in 1998 and came into force on 1st January 2001. The version on which the following information is based, dates from 2013. Information on the legal regulation can be found on the website of the Federal Office of Public Health (FOPH):

Reference: http://www.bag.admin.ch/themen/medizin/03878/03880/index.html?lang=en - accessed on January 4, 2016.

WHAT IS PROHIBITED

- Article. 4 prohibits the following practices: "Ovum and embryo donation and surrogate motherhood are prohibited".

- Article 5.3 states that "the removal and analysis of one or more cells from an embryo in vitro are prohibited", that is, PGD is prohibited so far. Since 2015, this article has been changed, but the change must still be amended.

- Article17.3 states that "the preservation of embryos is prohibited".

WHAT IS ALLOWED UNDER SPECIFIC CONDITIONS

- Sex selection of reproductive cells is allowed only "if there is no other way of avoiding the risk of transmitting a serious, incurable disease to the offspring" (Article 5.2).

- The use of donated sperm when the couple is married (Article 3.3).

- The use of ARTs is subject to the written consent of the couple which must be renewed after three unsuccessful treatment cycles (Article 7.1).

- Article 15.1 states that "reproductive cells may be preserved only with the written consent of the person from whom they were obtained, and for a maximum of five years". Article 15.2 adds that: "a longer preservation period may be agreed with persons who have their

reproductive cells preserved with a view to producing their own offspring at a later date because medical treatment they undergo or an activity they carry out could lead to infertility or damage to their genetic material". Consent may be revoked at any time (Article 15.3) and if the reproductive cells have not been used when the preservation period expires, they will be destroyed (Article 15.4).

- Article 16 regulates the preservation of fertilized ova (zygotes). It states that they can be preserved only if the "couple to be treated give their written consent; and preservation is intended to permit subsequent establishment of a pregnancy" (Article 16.1). "The maximum preservation period shall be five years" (Article 16.2) and "either partner may revoke his or her consent at any time in writing" (Article16.3). "If consent is revoked or the preservation period expires, then the impregnated ova are to be destroyed immediately" (Article16.4). It finally adds, that "the Federal Council shall prohibit the preservation of impregnated ova if the current state of science and practice allows non-impregnated ova to be preserved with satisfactory results" (16.5), which means that the freezing of oocytes should be preferred to the freezing of zygotes or fertilized ova.

- Article 17 regulates the development of embryos. It states that: "The number of impregnated ova developed into embryos outside the woman's body must not be greater than is required to establish a pregnancy within one cycle; the maximum number shall be three" (Article 17.1) and that "the embryo may only be developed outside the woman's body to the extent that is essential in order to permit implantation in the uterus" (Article 17.2). This article may change following the introduction of PGD which requires more embryos to be developed outwith the women's body in order to be worked on efficiently.

WHO HAS ACCESS

- The Article 3 determines access to ARTs based on the principle of the well-being of the child. It states that assisted reproductive techniques may be used only if the well-being of the child is ensured and may only be used in couples:

    a. where a basis for a parent-child relationship exists in accordance with Articles 252–263 of the Swiss Civil Code[3] (CC) and

    b. who, on the basis of their age and personal circumstances, are likely to be able to care for and bring up the child until it reaches the age of majority.

- It adds, that "only married couples may use donated sperm cells" and that "reproductive cells or impregnated ova may not be used after the death of the person from whom they were obtained".

- Access is also based on the indications restricting access to medical conditions. Article 5 states that "assisted reproductive techniques may be used only if:

  a. the aim is to enable a couple to overcome infertility and other treatment methods have failed or offer no prospect of success; or

  b. there is no other way of avoiding the risk of transmitting a serious, incurable disease to the offspring.

WHAT IS CURRENTLY CHANGING

- The preimplantation genetic diagnosis was prohibited in the RMA that came into force in 2001. A demand for the authorization of PGD was submitted to Parliament in 2004. A long process of consultation followed. In December 2014, the Parliament completed the consultation on the draft law and the new amended RMA states that PGD is allowed under specific conditions. The constitution article (n°119) had to be modified too, in order to allow the development of as many embryos as might be needed regarding what a specific treatment requires. These changes were adopted by popular vote on June 14, 2015. They will come into force, unless a referendum against these changes collects enough signatures within 100 days. More information on the authorization of PGD, as well as all official documents related to it, can be found on the official website of the Federal Office of Public Health (FOPH):

  Reference: http://www.bag.admin.ch/themen/medizin/03878/06152/index.html?lang=en - accessed on January 4, 2016.

- On 4th December 2012 an initiative was submitted demanding the authorization of egg donation

  Reference: http://www.parlament.ch/f/suche/pages/geschaefte.aspx?gesch_id=20120487 - accessed on January 4, 2016.

- On 16th January 2014 it was decided to follow this up, a decision confirmed by another commission on 10th April 2014. A commission was to be created in order to deal with the consultation process and the regulation transformation

  Reference: http://www.parlament.ch/f/suche/pages/legislaturrueckblick.aspx?rb_id=20120487 - accessed on January 4, 2016.

Other aspects not detailed here are developed in the RMA, such as the regulation of sperm donation, the control of medical activities (licensing and contraventions), and the ethical commission. For further information, consult the RMA which can be found online: https://www.admin.ch/opc/en/classified-compilation/20001938/index.html#a5 - accessed on January 4, 2016.

Appendix 3

ARTs in Switzerland

This appendix presents an overview of the situation of ARTs in Switzerland based on the FIVNAT Annual Report for 2013, published in 2014 and based on data from cycles collected in 2012. FIVNAT reports can be found on the website of the Swiss Society for Reproductive Medicine (SSMR):

Reference: http://www.sgrm.org/wb/pages/de/fivnat-kommission/statistiken_reports.php?lang=DE - accessed on January 4, 2016.

General overview

In 2012:

- 26 centres are affiliated. They are of different size and perform from 52 to 1315 cycles. Their list can be found on the following link: http://www.sgrm.org/wb/pages/fr/commission-fivnat/centres.php?lang=FR - accessed on January 4, 2016.

- The total number of treatment cycles is 9546, including transfers of fresh and cryopreserved zygotes. It has risen from 1% since 2009.

- The total number of patients treated is 5558. 91% live in Switzerland and 9% are from abroad.

- The total number of delivered known children is 1724, including 1709 alive, 9 dead in utero, and 6 unknown.

- 11.1% women undergoing treatment are below 30; 30% are between 30 and 34; 39.4% are between 35 and 39; 17.5% are between 40 and 44; and 2.1% are over 45. The mean age of women is 36.3.

- Use of embryos and zygotes: 869 were destroyed in fresh cycles; 792 were destroyed in cryo cycles; 2685 zygotes and 11 embryos were destroyed in destruction cycles; 10 embryos were donated to research. Reasons for destruction in fresh and cryo cycles are: development stop, bad development potential, decision of patients, other or unknown reasons. Reasons for

destruction cycles are: decision of patients, lost contact, end of the preservation contract, other or unknown reasons. The reasons for donating embryos to research are: development stop, bad development potential, decision of patients.

- Pregnancy rates by woman's age: below 30=> 26.2% fresh and 24.6% cryo; between 30 and 34=> 28.3% fresh and 24.5% cryo; between 35 and 39=> 21.6% fresh and 20% cryo; over 40=> 9.6% fresh and 11.7% cryo.

Costs

IVF is not reimbursed by the health insurance. According to the CPMA website, a private centre in the French-speaking part of Switzerland, IVF costs around 7000 CHF. Costs may vary depending on the proportion of hormones necessary for hormonal induction. When ICSI is performed, it costs 1000 additional CHF. A cycle including the thawing of frozen zygotes and their transfer in the uterus costs around 1800 CHF. The cryopreservation of oocytes costs between 4707 and 5197 CHF depending on the number of oocytes retrieved (more or less than 10). In the public centre of the University Hospital (UMR, CHUV), costs are a little lower. An IVF-ICSI costs 6470 CHF and a cycle of thawing 1780 CHF. More information can be found on the following links:

- http://www.cpma.ch/fr/treatments/index/couts-des-traitements.html - accessed on January 4, 2016.
- http://www.cpma.ch/fr/patients/costs.html - accessed on January 4, 2016.
- http://www.chuv.ch/reproduction/umr_home/umr-patients-familles/umr-infertilite/umr-couts_traitement.htm - accessed on January 4, 2016.

For more information on the Swiss situation of IVF, see De Geyter (2012). For a discussion about the views of patients giving embryos for research, see Haimes et al. (2008).

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